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CONTENTS

	Page
Reason and Survival in the Modern World	521
Science and Petroleum. By Lt.-Col. S. J. M. Auld, O.B.E.	522
Chemistry of Naphthalenes and Sterols. By Dr. J. W. Cook, F.R.S.	523
Textile Progress	524
The Story of the Vitamins. By Prof. John Yudkin	524
Liberty in the Modern World. By R. Brightman	525
University College of North Wales, Bangor: New Science Buildings. By Prof. P. W. Richards	527
Plant Growth Substances: Third International Conference. By Prof. L. J. Audus	529
Relation of Genetics to Population Studies	532
Obituaries:	
Prof. J. C. Flugel. By Sir Cyril Burt	533
Mr. Philip Lyle. By H. C. S. de Whalley	534
Sir Francis McClean. By Prof. F. J. M. Stratton, O.B.E., F.R.S.	534
News and Views	535
Commonwealth Scientific and Industrial Research Organization, Australia: Report for the Year 1953–54	540
Scientific Research and Man-power in the United States	543
Plasticity of Materials: Symposium in London. By H. G. Hopkins	544
Brazilian Society for the Progress of Science: Annual Meeting	544
Problem of Rewarding Responsibility	545
Atmospheric Pollen	546
Growth and Titration of the Viruses of Foot-and-Mouth Disease and Vesicular Stomatitis in Kidney Monolayer Tissue Cultures. By R. F. Sellers	547
Blood Counts in Domestic Animals in the Gold Coast. By Prof. E. E. Edwards, J. M. Judd and F. A. Squire	549
Letters to the Editors:	
Identity of Cephalosporin *N* and Synnematin *B*.—Dr. E. P. Abraham, G. G. F. Newton, B. H. Olson, D. M. Schuurmans, J. R. Schenck, M. P. Hargie, M. W. Fisher and S. A. Fusari	551
Some Observations on the Crystal Structure of a Chlorine-substituted Vitamin B_{12}.—M. J. Kamper and Dr. Dorothy Crowfoot Hodgkin, F.R.S.	551
An Effect of Antibiotics produced by Plankton Algae.—Prof. E. Steemann Nielsen	553
A Possible New Vitamin A_1 Isomer in the Eyes of Crustaceans.—Georg Lambertsen and Olaf R. Brækkan	553
High-potency Vitamin A_2 Oils from Indian Freshwater Fish.—S. Balasundaram, Dr. H. R. Cama, P. R. Sundaresan and T. N. R. Varma	554
Adrenaline and Noradrenaline in Tissues of Normal, Insulin-treated, and Adrenalectomized Rats.—Katharine Montagu	555
Studies on Transaminase and Decarboxylase catalysed by Extracts of the Silkworm, *Bombyx mori* L.—B. Bheemeswar	555
Effect of 8-Azaguanine on Enzyme Formation.—E. H. Creaser	556
Occurrence of Chitin in the Epicuticle of an Arachnid *Palamneus swammerdami*.—Dr. G. Krishnan, G. N. Ramachandran and M. S. Santanam	557
Measurement of Surface Pigmentation in Animals.—A. J. Lea	558
A Method for sampling Arthropods and Molluscs from Herbage by Suction.—Dr. C. G. Johnson, Dr. T. R. E. Southwood and Mrs. H. Entwistle	558
A Water-soluble Filter for trapping Airborne Micro-organisms.—Merfyn Richards	559
A Direct Measurement of the Energy Locally Absorbed from a Gamma-Ray Beam.—Prof. H. E. Johns, J. P. Bernier and D. V. Cormack	560
Mineralogy and Crystal Structure of Chamosite.—R. F. Youell	560
Structure in Vitreous Silicates as shown by Low-angle Scattering of X-Rays.—L. C. Hoffman and W. O. Statton	561
Lowered 'Capillary Resistance' after Iontophoresis of Lysergic Acid Diethylamide.—E. L. Blair, Mavis Wakefield, G. I. C. Ingram and P. Armitage	563
Turbidimetric Measurement on Synchronized *Salmonella typhimurium* Cultures.—Dr. V. G. Bruce, K. G. Lark and O. Maaloe	563
Approximate Joint Probability Distribution for Wave Amplitude and Frequency in Random Noise.—R. A. Wooding	564
Use of a Computing Machine as a Mechanical Dictionary.—Dr. Andrew D. Booth	565

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REASON AND SURVIVAL IN THE MODERN WORLD

NEARLY twenty years ago, in his Conway Memorial Lecture, under the title "The Retreat from Reason", Prof. L. Hogben argued that this 'retreat' was the result of our failure to ensure that, on one hand, the training of the statesman and the man of letters gave them prevision of the technical forces which were shaping the society in which they live, whereas, on the other hand, the education of the scientist and the technician did not make them aware of the social consequences of their own activities. It was accordingly necessary to devise an education which would give us representatives capable of co-operating intelligently with technical experts in constructive social enterprise, and teach us how to choose them. Prof. Hogben then developed his argument for encouraging a wider knowledge of science as a means to action, and outlined a proposal for an institute of social inquiries, and in doing so made numerous comments—for example, that the most expensive products of modern social organization are uneducated men—the truth of which has been amply attested in recent months.

Prof. Hogben's lecture is recalled to mind by the appearance of a special number of *The Political Quarterly* in which, under the general title "The Revolt against Reason", a series of nine articles examines from different angles the evidence for the alleged great reversal during the past forty years of the nineteenth-century climate and movement of ideas, and whether in fact there has been a great revolt against reason, science, and the ideas and ideals of the French Revolution. While, however, the articles indicate that there has indeed been a revolution in scientific thinking and a profound change in the whole climate of our thought, they reveal no convincing evidence of the cataclysmic failure of, or revolt against, reason. The result has been rather a deep confusion, a loss of direction in the political and social mind, both of the expert and specialist and of the ordinary man. The symposium suggests that if we eventually digest the new ideas and adapt ourselves to the new conditions, then we must do it with the aid of reason; but there the affinity with Prof. Hogben's lecture ends. A challenge to thought there may be, but scarcely one to action.

Of the nine articles, those in which Dr. J. Bronowski deals with science, Mr. R. Wollheim with philosophy, and Mr. Noel Annan with the general intellectual revulsion to the right may be of most interest to the man of science. Those of Prof. D. Emmett on religion, of Mr. D. G. MacRae on social science, of Mr. L. Woolf on history, and of Mr. H. R. C. Greaves and Mr. W. Pickles on political thought in Britain and in France, are required, however, to complete the picture of the existing climate of belief, while finally, Mr. R. Bryden analyses the attitude of the younger generation in the universities.

The real situation is well shown by Dr. Bronowski, who proves as stout a champion of reason as any product of the nineteenth century. Discoveries connected with the atom, quantum theory and relativity have made some of the assumptions or conclusions of Newtonian science untenable. The new thought in science is based none the less on new facts, and its predictions have a formidable accuracy, as well as a calculated uncertainty within which we work confidently and methodically. We recognize now that the world is not made in a pattern which can be described by specifying its separate points; but this lends no support to the argument that we can safely abandon the use of reason and substitute the instrument of faith. Nuclear science has released neither scientist nor layman from the duty of using his reason; on the contrary, it has made the scrupulous use of reason even more essential for survival. Similar thoughts were evidently in the mind of Sir Robert Robinson when he spoke in his presidential address to the British Association meeting at Bristol of the need for the freeing of information in this field.

Mr. Wollheim's review of modern philosophy and unreason leads to a like conclusion: that to stand on the side of reason is a matter not of arriving at certain conclusions but of using certain methods. Prof. Emmett, surveying much the same field but more particularly in relation to discussions on religious questions, can find no unequivocal evidence of a revolt against reason but insists rather that there is a problem of communication to be solved. She suggests that there may be signs that a more widespread awareness of problems raised by our uses of language, questions from which not even an exposition of theology can be immune, may lead to a greater readiness on all sides to try to see what it means to be rational in questions which touch ultimate attitudes and beliefs.

It might have been expected that Mr. MacRae, tracing the influence of irrationality and obscuration in the social sciences, would come nearer to Prof. Hogben in his conclusions. While, however, he shows as clearly as Prof. Hogben the obstacles which hinder the development of the social sciences to-day, and agrees with him that only growing rational understanding can give to men control of their natures and of their societies, Mr. MacRae is not concerned with practical problems. He finds no evidence of a genuine retreat from reason and observes that the decision to follow reason is always a moral choice, but in the social sciences in the mid-twentieth century, the task of following reason is a technical one.

Nor do Mr. Annan's or Mr. Greaves's articles warrant pessimism. Mr. Annan's examination of the factors responsible for the intellectual movement to the right leads him to suggest that politically we live again in the age of Bagehot, and that what is needed is a new series of cohesive arguments which will again persuade people that our institutions need changing, not modifying, and that reason is a tool for discovering what changes are necessary and not a means of justifying the present and explaining why it can never improve. Mr. Greaves concedes that the belief in an inevitable progress along pre-

determined channels of rational, humanitarian, democratic advance has gone, but not that there is real evidence of any failure to relate the stability of institutions in a precarious world to the old principles of rational humanitarianism. There is certainly wider agreement now than at the beginning of the century on basic principles and on objectives, and while that agreement may be less optimistic as to the essential reasonableness of human nature and the inevitability of progress, it is not anti-rational or anti-democratic.

Mr. Bryden's survey of the attitude of the younger generation in the universities ends on a like note. The apparent revolt against rationalism there, in his opinion, amounts not to rejection of the tradition of Bentham and Mill, but to a re-examination of the other tradition, from Coleridge to Green, which in retrospect seems to amount to the philosophy of the other great force which complemented nineteenth-century liberalism. Rationalism, he insists, may have entered the wilderness, but its younger disciples in the universities show themselves determined not to let it die out. Then in two sentences he brings the symposium closer to practical issues than his fellow-contributors seem to do. "If the tradition of rationalistic radicalism does not stir the universities as it once did, surely this is because the universities have lost their sense of community with the rest of the nation." There may have been no deliberate abdication of leadership, but it is scarcely possible for the scientist to be disliked and distrusted by the public in the way that Dr. Bronowski remarks unless the universities have failed to rise to their responsibilities of intellectual leadership. Quantitatively, their post-war expansion should have greatly enhanced their influence on public opinion in Britain, and a failure to seize the wider opportunities may well account in part for difficulties in shaping educational policy to public needs, whether we look, for example, at the expansion of technical and technological education or at the continuing shortage of science teachers. Moreover, the lacuna to which Mr. Bryden directs attention has its dangers for the universities themselves, as Sir Hector Hetherington made abundantly plain in his Anderson Memorial Lecture on "The British University System" delivered in Aberdeen last year*. Academic autonomy depends ultimately on public understanding of what the universities are doing and how best their work is done.

For the second practical issue: if the twentieth century has made anything clear, it is that nations are all too concrete; it may be irrational to adore societies; it seems still more irrational to ignore their existence and their strength. Set those words in the context of some of the platitudes with which distinguished contributors to "The Bomb: Challenge and Answer"† were content to leave the problems with which nuclear energy confronts mankind, and the imperative need for keen, rational thinking which now confronts mankind is plain. Here, at least, and in Dr. Bronowski's essay, a challenge is thrown down in quiet confidence that reason still offers a guide, and the only sure guide, to the right answer to problems of to-day.

The call to action is given less insistently than it was by Prof. Hogben, but it is there none the less. We may be less confident where reason will take us, and we recognize that there are fields of human experience of which science can tell us little or nothing. But that hard thinking and readiness to follow the argument and pursue the inquiry wherever they lead are the essential conditions for solutions to the problems of human survival and existence are as true to-day as ever. For an effective policy, however, we need, as Sir Richard Livingstone reminds us, clear and firm beliefs. Without them we may not only fail to draw the moral lessons we might from history, but also our thinking may lead us not to action but into a miasma of doubt and frustration. Mr. Woolf's contribution to the symposium, at least, displays that danger; but for the rest the symposium has little of the 'ivory tower' about it. Its challenge to hard thought contains more than a hint that such thinking needs to crystallize in action, and indicates at least some of the enterprises of great moment to which our thought should lead.

* The British University System 1914–1954. By Sir Hector Hetherington. (P. J. Anderson Memorial Lecture, 1954. Aberdeen University Studies—No. 33.) Pp. 13. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 1s.

† The Bomb: Challenge and Answer. By Prof. Alexander Haddow, Bertrand Russell, Lord Beveridge and Henry Usborne. Edited by Gilbert McAllister. Pp. 160. (London: B. T. Batsford, Ltd., 1955.) 25s. net.

SCIENCE AND PETROLEUM

The Science of Petroleum

A Comprehensive Treatise of the Principles and Practice of the Production, Refining, Transport and Distribution of Mineral Oil. Vol. 5, Part 3: Refinery Products. Edited by Dr. B. T. Brooks and Dr. A. E. Dunstan. Pp. ix+398+23 plates. (London: Oxford University Press, 1955.) 126s. net.

THIS is the most recent addition to the four original volumes published in 1937 and is the fourth supplement to be issued. As it may represent a stage in the successive renewals of an outstanding record of the science and technology of mineral oil, opportunity is taken of referring to the work as a whole. The conception of "The Science of Petroleum" was heroic. It was the thought of A. E. Dunstan more than any other, who sought a means of overcoming the ever-increasing pressure of advancing knowledge required by the man of science and the technologist in an industry of the widest interests, without having immediate recourse to the very many original publications in journals and monographs spread throughout the world's literature. It was not to take the form of a series of abstracts or summaries, nor to be a collection of treatises; but to become an ever-living progression of articles concerned with aspects, achievements and trends written by contemporaries of acknowledged authority. The attempt was successful. "The Science of Petroleum" will continue to live and flourish indefinitely.

The first half of the contents of "Refinery Products" is mainly directed to the characterization of commercial fractions of crude oil as separated at the 'refinery', and ranging from aviation and motor

gasolines through middle distillates to white oils and waxes. The remainder is mostly concerned with the elaboration of test methods. There is therefore little process and manufacturing material additional to that appearing in Vol. 5, Part 2, and what there is deals with relatively minor products and their applications. It had been hoped that in suitable guise room could have been found for description of the more recent developments in directive catalytic hydroforming and desulphurizing, which are having a truly profound influence on refinery practice and products. But at the pace new volumes are being prepared for the series, one may not have to wait overlong for such disquisitions.

There are many noteworthy essays in the volume, and one is forced into generalities of appreciation; but it is perhaps in the matter of testing that the high standard of modern petroleum technology is best portrayed. Both for length and substance (close on one hundred pages) the contribution of W. G. Lovell on the knocking characteristics of hydrocarbons is a good example. Here is a subject based on engine testing, many of the data of which are those resulting from the American Petroleum Institute Research Project 45. It is a subject which will with difficulty reach finality because of the friendly competition between chemist and automobile engineer, each in turn taking the lead in providing or demanding motor fuels of higher octane rating. The procedure for engine-testing appraisement of light fuels has already been standardized between the American Society for Testing Materials and the Institute of Petroleum. The two articles on engine testing of lubricating oils are a reminder of the impetus given also to this important subject by the Co-ordinating Research Council of New York and willingly followed up and developed by British engine manufacturers and oil companies.

The last big section of the volume is impressive in its indication of the extent to which modern advances in infra-red spectroscopy, Raman spectroscopy and the use of the mass spectrometer are being applied in hydrocarbon studies and analysis. Imposing, too, are such articles as those of D. Tabor and F. P. Bowden on boundary lubrication, and of J. M. Robertson on X-ray examination of hydrocarbons. But modestly among these more learned contributions, yet of great importance to the subject of international standardization, is one of barely five pages by H. Hyams on volume and specific-gravity corrections for petroleum oils. The chief reference in this article is to the work carried out by the Institute of Petroleum and the American Society for Testing Materials in the preparation, and now the joint publication, of "Tables for Petroleum Measurement". This is the first, and by no means likely to be the last, instance of fully collaborative effort between the petroleum technologists of Great Britain and the United States.

The three impressive volumes which have recently been produced are not merely evidence of this spirit, but fully justify Hyams's claim that they will eliminate buying and selling differences and difficulties throughout the great areas primarily concerned, and will assist in the establishment of world-wide uniformity: this will be a great achievement in the commercial domain of the world's outstanding commodity. The book is a pleasure both to scan and to skim. The Oxford University Press continues its very high standard of production for this great work.

S. J. M. Auld

CHEMISTRY OF NAPHTHALENES AND STEROLS

Elsevier's Encyclopædia of Organic Chemistry
Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Volume 12*B*: Naphthalene. (*A*) Compounds containing One Naphthalene Nucleus. Oxo-Derivatives of the Naphthoic Acids; Naphthalenepolycarboxylic Acids. Pp. xliii+4561–4840+34; £10 15*s*. Vol. 14: Supplement. Nor-Steroids. Steroids: Hydrocarbons, Halogen, Nitrogen, and Unsubstituted Monohydroxyl Compounds. Edited by A. Georg, with the assistance of M. Georg-Plant. Pp. xxxix+1347*s*–1868*s*; £18.
(Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1954.)

THE first of these two books is the eighth part of a series and marks the completion of a further stage in the cataloguing of naphthalene derivatives. It is stated that the literature has been consulted up to and including 1944, and the literature concerning the structure of compounds up to the beginning of 1954. The field covered includes derivatives of the naphthoic acids containing carbonyl groups, naphthoic acids containing other carboxyl groups in a side-chain, with their homologues and derivatives (with halogen, nitrogen, hydroxy and carbonyl substituents). Naphthalenepolycarboxylic acids are also covered. In this latter group naphthalic acid is perhaps the most important. As in other parts, corresponding hydronaphthalene derivatives are also treated. Descriptions are given, for example, of formylnaphthoic and benzoylnaphthoic acids and their homologues, tetralone- and decalone-carboxylic acids, and diketo-hydronaphthoic acids. In the diterpene series, a full account is given of the chemistry of agathic acid, the reactions of which are summarized in a typically informative reaction scheme covering two pages. No system of classification is perfect, and it is perhaps a little unfortunate to find such a compound as neolithobilianic acid dealt with in this part, rather than in the volume dealing with bile acids and their derivatives. The list of periodicals occupies eighteen pages, and inevitably covers much the same ground as similar lists in other parts.

The high standard of production with which users of the "Encyclopædia" are familiar is well maintained, with excellent printing, freedom from error and beautifully set formulæ. When Vol. 12*B* is complete, it will be regarded for many years to come as the unique work of reference on naphthalene chemistry.

Vol. 14 of the "Encyclopædia", dealing with carbocyclic compounds containing more than three rings, was the first volume to be published, and it covered the literature up to 1936. It contained 711 pages, 276 pages of which were devoted to the steroid group. In the second of the two books now under review, the range of compounds dealt with in 521 pages of text and 44 pages of index corresponds to 80 pages of the original Vol. 14. This is some measure of the extent of the interest shown in the steroid group in a single decade; for the present work covers the literature up to 1946, with references to the literature concerning the structure of compounds up to 1954.

The book is concerned essentially with the sterols and related hydrocarbons, and derivatives containing halogen, nitrogen and monohydroxy substituents. It seems destined to become *par excellence* the standard

work of reference on sterols. A description of cholesterol and its simple derivatives occupies some 120 pages. These include accounts of physical properties, occurrence and formation, reactions and physiology, with descriptions of the addition compounds of cholesterol, its esters and its ethers. The steroid hormones, the bile acids, and the other main groups of steroids are reserved for future parts of the supplementary volume. Brief accounts of sterols of unknown structure may be expected to stimulate further research.

There is a description of the currently used steroid nomenclature, which has been adopted in the text, and the formulæ show configurations so far as these are known. There are fifteen tables summarizing the properties of closely related sets of compounds, the index gives a complete list of naturally occurring compounds considered in the text, and there is a separate formula index. This book is particularly rich in editorial footnotes which correct errors in original papers, direct attention to uncertainties and ambiguities, and in many cases make valuable suggestions as to structures of compounds. One very minor error has been detected in the text—the name "conessine" is mis-spelt on p. 1392*s*. It is no longer true, as stated on p. 1382*s*, that 1 : 2-*cyclo*pentadienophenanthrene has not yet been prepared, and this may have some bearing on the comments on pp. 1389*s* and 1811*s* about the 3′-methyl derivative.

Reaction schemes, which are a characteristic feature of the "Encyclopædia", figure to some extent in the present work, examples being schemes showing the relationships of some of the cholestadienes (p. 1419*s*) and the oxidative degradation of the side-chain and ring *D* of cholesterol (p. 1583*s*). The biosynthesis of cholesterol is briefly discussed; but there is no mention of the use of precursors containing carbon isotopes. In spite of the excellent monographs on steroids which are available, this is a work which no one concerned with the chemistry of sterols can afford to be without.

J. W. Cook

TEXTILE PROGRESS

Review of Textile Progress

Vol. 4, 1952; pp. 560; 35*s*. Vol. 5, 1953; pp. 588; 35*s*.
(Manchester: Textile Institute; Bradford: Society of Dyers and Colourists, 1953 and 1954.)

TEXTILE scientists and technologists have come to look forward to this annual "Review of Textile Progress", which usually appears towards the end of the year following that to which the account relates. Vols. 4 (1952) and 5 (1953) follow the same format as previous volumes, and the size of the book, which increased up to Vol. 3, has now become stabilized. The subjects covered include the physics and chemistry of fibrous materials; fibre production; conversion of fibres into finished yarns; fabric production; colouring matters; colouring of textiles; finishing of textile fabrics; analysis, testing, grading and defects; laundering and dry cleaning; building and engineering; and industrial applications of textiles.

Some thirty authors contribute the twenty-six subsections and, resulting from the policy of the joint committee, the authorship has changed considerably so that in Vol. 5 only seven of the sub-sections have the same authors as in Vol. 3 and only three authors of Vol. 1 remain as contributors to Vol. 5. However, the high standard set by Vol. 1 has been maintained. In Vol. 4 the physics and physical testing of fibrous materials was brought under one authorship to avoid overlapping, and in Vol. 5 physical testing has been transferred to its rightful place under the general heading of analysis, testing, grading and defects. Unfortunately, some unnecessary repetition has occurred; for example, references 24, 25, 44, 45, 48 in the section on physical testing duplicate references 72, 73, 77, 76, 90 in the section on physics.

In the period under review there has been a rapid expansion in the production of synthetic fibres, and it is not surprising to find a large number of papers concerned with the difficult problem of their dyeing and with applications in which their characteristic properties can be used with advantage. It should be noted that many of the so-called new fibres being produced are basic types with new trade names. Numerous patents covering fibre-forming polymers have been filed, but fibres from them will not be produced commercially unless they have really outstanding properties. The natural fibres have not been neglected. Thus, the cotton fibre has received much attention, and the resulting modifications such as cyano-ethylated cotton, together with the growth of resin treatment and embossed finishes, promise to open up new applications. Many theoretical papers with a direct bearing on the spinning and preparation processes have appeared and will influence the design of machines to give improved quality and higher productivity per operator. The dyeing of fibres appears to be passing through a period of consolidation of the new ideas published during the past five years. In printing, interesting papers on engraving have overshadowed those on mechanical invention.

There are some three thousand references in each volume to scientific and technical publications and to British and American patents; but this does not mean that the "Reviews" are simply catalogues. The accounts are essentially readable, so that one can start anywhere and become so engrossed that the end of a section is reached all too soon. Extensive author and subject indexes enable the reader to find something he has read about and may wish to read again; they also help when using the "Reviews" as source books of information. All who have taken part in producing these volumes are to be congratulated.

THE STORY OF THE VITAMINS

Vitamins in Theory and Practice

By Dr. Leslie J. Harris. Fourth edition. Pp. xxii + 366. (Cambridge: At the University Press, 1955.) 35*s*. net.

AFTER three editions of this book between 1935 and 1938, we have had to wait seventeen years for the fourth edition. It can be said at once that Dr. L. J. Harris has again produced by far the most readable, indeed fascinating, account of the vitamins which has yet appeared.

In simple language and in the clearest style, Dr. Harris tells the story of how the existence of the vitamins was discovered and how each was recognized and defined. The story is enthralling; so often one has read the same facts and been left quite unmoved by a cold recitation of dates and data—perhaps because we are too much concerned about the very latest developments and forget how exciting the earlier story is. Especially we overlook the brilliant work of some of the earlier investigators and how much we can still learn from their approach and

their methods. Dr. Harris evokes the same interest in the description of each vitamin—where it occurs, the effects of deficiency in animals and in man, its chemistry and mode of action. By ingenious tables and figures, of which there are more than a hundred of each, essential points are frequently summarized and clarified throughout the book, so that, in spite of its easy readability, the student using it as a text-book will find it admirably suited to his needs. The final section of the book has useful and important things to say on dietetics—the application of nutritional science to the feeding of man. Here are discussed questions of food choice and instinct, the effect of war and rationing, ideal diets and common food faults.

While there is no doubt that this is by far the best book, at a fairly elementary level, which has been produced on the subject of the vitamins, one must reluctantly say that even so it is not the ideal book. One would have liked to see a rather more ruthless pruning of some of the older material and its substitution by newer information. The book abounds in examples of how Dr. Harris, better than so many other writers, could have achieved this. While most of us still remember that the Dutch East Indies are now Indonesia, how many remember which country was once Bosnia? Is it not now accepted that "a scaly follicular eruption" of the skin is by no means a "fairly clear symptom of vitamin A deficiency"? Anti-vitamin K has not merely a *possible* use in medicine—it is, in fact, used extensively. It is misleading to say that riboflavin deficiency is "uncommon in most regions of the globe". It is a pity, too, that reference has not been made to the Bataan experiment, where beriberi has been almost completely eradicated by the enrichment of rice, nor to the claims—mostly unfounded, it is true—of the therapeutic uses of vitamin E. Apparatus described for measuring dark adaptation has long been recognized as unsatisfactory.

However, let it be said once again that these small criticisms still leave this book easily the best to recommend, not only for students of nutrition but also for anyone who is interested in a subject about which there is so much misinformation. It is well produced, a pleasure to handle and a joy to read.

JOHN YUDKIN

LIBERTY IN THE MODERN WORLD

The Spirit of Liberty

Papers and Addresses of Learned Hand. Collected, and with an Introduction and Notes, by Irving Dilliard. Pp. xxx + 285. (London: Hamish Hamilton, Ltd., 1954.) 21*s*. net.

THE papers and addresses collected in this book range for the most part over fields with which the man of science is concerned rather as citizen than as scientist. Even here, they could help to correct the immaturity and lack of education, to the dangers of which Conway Zirkle directed attention in a forceful address last December to the American Association for the Advancement of Science. The book takes its title from the brief address which Judge Learned Hand gave in May 1944, and the main interest of the book to the scientist lies in the interpretation of liberty and its significance in the world to-day, given by a cultured legal mind. In addresses on sources of tolerance, on liberty, on the contribution of an independent judiciary and on the debt of the world to Greece, and in the plea for the open mind and free discussion which he made as recently as October 1952, there is clear appreciation of the conditions of scientific advance or any other form of intellectual activity, of the responsibilities which the creative worker must recognize and penetrating analysis of what is involved in living together in an ordered society. Here are displayed no ready-made solutions but the ripe wisdom of a cultured mind, rich in inspiration, and confident of its exposure of humbug and pretence.

"Liberty," the author writes, "is an essence so volatile that it will escape any vial however corked. It rests in the hearts of men, in the belief that knowledge is hard to get, that man must break through again and again the thin crust on which he walks, that the certainties of to-day may become the superstitions of to-morrow; that we have no warrant of assurance save by everlasting readiness to test and test again." Elsewhere in the book he writes of the function of the scholar in a democratic State and the influence of his detachment in assuaging the faction which, admitting no mediation and demanding the extinction of all opposition, would convert the State into an autocracy "except in so far as the state is made up of those, to some degree practised in the habit of suspended judgment, and possessing a spirit capable of disinterested scrutiny". Nor does he incite the scholar or scientist to rash political action. "You cannot raise the standard against oppression, or leap into the breach to relieve injustice, and still keep an open mind to every disconcerting fact, or an open mind to the cold voice of doubt." The scholar must be content to be himself, confident that, if faithful in that, his light will shine, steady and far. Judge Hand believes in the spirit of moderation and toleration, that the scholar, whether scientist or other, brings his contribution by pursuing his inquiry where it leads him, by just 'monkeying around', by continually thinking out afresh the concepts of 'liberty' and 'independence' and the like in the context of to-day, and refusing to accept false values in their place, by maintaining wide horizons and a suspended judgment in the times of stress when men are most prone to reject them.

Supremely the book testifies to the truth of Judge Hand's contention that there is no substitute for an open mind enriched by reading and the arts, and that the scientific worker who would influence the thought and action of his time must have some acquaintance, the wider the better, with what others have thought and felt in circumstances as near as possible to those of the groups in question. Here is the fundamental reason why an education which includes the humanities is essential to correct the political immaturity of the scientist. "Just as in science we cannot advance except as we take over what we inherit, so in statecraft, no generation can safely start at scratch. . . . The imagination can be purged and the judgment ripened only by an awareness of the slow, hesitant, wayward course of human life, its failures, its successes, but its indomitable will to endure." The plea for the open mind and free discussion in which these words occur is much more than championship of dissent and a direct rebuke to the excesses of McCarthyism and secrecy and security procedures: it is an outstanding statement of the case for general education as the basis of a free society.

R. BRIGHTMAN

Atomphysik

Von Dr. Karl Bechert und Dr. Christian Gerthsen. Band 1: Allgemeine Grundlagen, Teil 1. Von Dr. Gerthsen. (Sammlung Göschen Band 1009.) Pp. 124. 2.40 D. marks. Band 2: Allgemeine Grundlagen, Teil 2. Von Dr. Christian Gerthsen. (Sammlung Göschen Band 1033.) Pp. 112. 2.40 D. marks. (Berlin: Walter de Gruyter and Co., 1955.)

THE "Sammlung Göschen" used, in the past, to provide the intelligent amateur, the teacher and the young student with short tracts on general or restricted fields of science, technology, history and philosophy and language, etc., attractively written, well printed and generally comprehensive. Since they were cheap, they allowed one to build up a valuable library which contained a great deal of information without the expenditure of a lot of money.

The "Sammlung Göschen" continues to be issued by Walter de Gruyter and Co. in succession to G. J. Göschen'sche Verlagshandlung. The two volumes under review, each of about a hundred and twenty pages, form Part 1 and Part 2 of a four-volume account of atomic physics. It is noteworthy that the joint authors, Karl Bechert and Christian Gerthsen, are both full professors at universities. The text sets out with great clarity the basic experimental facts upon which the large structure of present-day atomic physics is based, with little theory attached to it and not many formulæ. Both volumes are written with great lucidity, and the skill with which the different aspects are explained shows that the authors have considerable teaching practice. The figures and the reproduction of photographs are remarkably good for a volume of this small size (4 in. × 6 in.). I am sure these little booklets will contribute considerably to stimulating the interest of the younger generation in the physical sciences, and in view of their cheapness may well have some influence on the supply of young physicists.

In the past, Göschen used to offer its volumes cloth bound. It is regrettable that the present issue looks rather fragile and would, presumably, soon come to pieces. E. Bretscher

Copper

The Science and Technology of the Metal, Its Alloys and Compounds. Prepared under the Editorial Supervision of Allison Butts. (American Chemical Society Monograph Series—No. 122.) Pp. xii+936. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1954.) 160*s*. net.

TO anyone interested in copper the value of this book is inestimable. It seems to cover every aspect of production, technology and physical and chemical properties, as well as the diverse applications of the metal and its compounds. The foregoing simply does not do justice to the extent of the subject-matter, consisting as it does of forty-six chapters each on a separate topic. However, to mention a few less obvious topics—namely, isotopes of copper, its analytical chemistry, metallography of copper and its alloys, application in organic chemistry and agriculture, and biological considerations—perhaps will help to indicate better the tremendous scope of this book.

The fifty-three specialist contributors are mainly from American organizations, although there is some British and Canadian representation. Considerable latitude has been allowed to the writers in the presentation of their subjects, and the results are distinctly agreeable with respect to balance and style. The subject-matter is thoroughly up to date and is well illustrated. The printing and the paper are pleasing. The editor and publishers are to be congratulated on the production of a first-class reference book. A. R. Bailey

Michael Tswett's First Paper on Chromatography

By Gerhard Hesse and Herbert Weil. Pp. 35+2 plates. (Eschwege: M. Woelm, 1954.) n.p.

THE booklet is published in English and contains Tswett's preliminary communication entitled "On a New Category of Adsorption Phenomena and their Application to Biochemical Analysis", which was read in 1903 to the Warsaw Society of Natural Sciences. Although not as well known as his famous paper of 1906 on chromatographic adsorption analysis, it is clearly the forerunner of that paper. In the 1903 communication, Tswett systematically tested more than a hundred substances as adsorbents for leaf pigments and described how stepwise removal of the components from solution could be achieved by adding small quantities at a time of certain adsorbents. He also described separations of pigments on simple column-chromatograms and was able by similar means to separate the colourless substance, lecithin, from impurities, by elution through an inulin column. One is struck by the elegance of Tswett's work and how, from a few simple observations and understanding of the principles involved, he devised a technique which was destined to have such a profound influence. Following the paper, there is a section consisting of editorial notes on the paper and finally a biographical section which includes some interesting, recently discovered details of Tswett's life. R. Consden

A Handbook of the Palace of Minos at Knossos, with its Dependencies

By J. D. S. Pendlebury. Pp. 76+14 plates. (London: Max Parrish and Co., Ltd., 1954.) 12*s*. 6*d*. net.

JOHN PENDLEBURY was one of the more brilliant younger Ægean archæologists between the two World Wars. He was the curator at Knossos during 1929–34. In 1939 he published a major work, "The Archæology of Crete", which is a model for a book of its kind. He also did a considerable amount of work in Egypt at Tell El-Amarna. In Crete in 1941 he was wounded, captured and then shot by the Germans.

The ruins at Knossos are very extensive and complicated; they are also frequently visited both by serious students of Near Eastern archæology and by tourists. Many years ago Pendlebury set himself the task of producing a guide to the ruins which would at the same time be scientific, intelligible and readable. This handbook has long been out of print and has now been re-issued in a new edition with an introduction by the late Sir John Myres and Sir John Forsdyke. Very little previous knowledge is assumed, and the reader at once realizes the sequence of happenings at Knossos during the nine periods into which the story of prehistoric Crete is divided. There follows an itinerary through the buildings, both of the main palace and of the dependencies outside. There are a number of excellent illustrations.

The new handbook, like its forerunner, meets a real need and will be welcomed by serious students and intelligent tourists alike. M. C. B.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

NEW SCIENCE BUILDINGS

By Prof. P. W. RICHARDS

THE new building for the Botany and Forestry Departments and the extensions to the Departments of Chemistry, Physics and Zoology of the University College of North Wales, Bangor, were opened on May 20 by Sir Keith Murray, chairman of the University Grants Committee. At the ceremony in the Powis Hall before the formal opening, many representatives of universities and other guests were present, including several representatives of the French Forest Service, which has on a number of occasions hospitably entertained forestry students from Bangor during their annual tour of French forests. One of these representatives, Prof. P. Silvy-Leligois, of Nancy, brought with him a message of good wishes from the École Nationale des Eaux et Forêts.

From the foundation of the University College of North Wales until 1926 the scientific departments were housed near the harbour. The old building, which is now demolished, was opened by Lord Kelvin (then Sir William Thomson) in 1885. The original intention had been to build more spacious accommodation by extending the College's main building in Upper Bangor (finished in 1910); but after the First World War it was decided that a major part of the North Wales Heroes Memorial Fund should be used for providing new science buildings on a site in Deiniol Road. These buildings were completed in 1926 and opened by Sir J. J. Thomson.

Until the Second World War, the number of students in the College did not exceed five hundred, less than half of whom were studying scientific subjects, and the Memorial Buildings, as they were called, proved adequate for their purpose. After the War, the size of the College more than doubled, and it became evident that the number of undergraduate scientists, let alone staff and research workers, was likely to remain permanently far larger than the Memorial Buildings could accommodate. It was thus the need for larger teaching laboratories, as well as for better research facilities, which led the College, with the generous support of the University Grants Committee, to embark on an ambitious building programme, involving the complete rehousing of the Botany and Forestry Departments and increased accommodation for the other science departments. As an essential first step, the College bought in 1947 the Tanrallt site adjoining the Memorial Buildings. It is here that the physics extension and the largest of the new buildings, that for botany and forestry, have been built.

All the new science buildings at Bangor have been designed by Sir Percy Thomas and Son, of Cardiff, and they have been built mainly by Messrs. W. T. Nicholls of Gloucester.

The first of the new buildings to be finished was the new chemistry building, which has been in use since 1950. It extends but does not replace the older building (the Orton Laboratories) and is on a closely adjacent site. In honour of Sir James Dobbie (1884–1903), the first professor of chemistry at the College, it has been named the Dobbie Laboratories. Owing to limitations of space, it has had to be built on a steeply sloping and confined site; to fit into this, it has been built in a single story in part over a semi-basement. It provides two teaching laboratories (with overhead services of gas and water) for eighty and sixty-four undergraduate students respectively, as well as a research laboratory for twelve postgraduate students, a departmental library and reading room, together with auxiliary rooms, including a general operations laboratory, an instrument room, a cold room, a room for chromatography, balance rooms and stores. There is also a lecture room seating 220, the largest in the science departments of the College.

The Department of Zoology, like the other science departments, had long outgrown its accommodation. The old Biology Block, previously shared by the Botany and Zoology Departments, has been adapted and completely refitted to provide for the teaching needs of the Department of Zoology and now includes two lecture rooms, a large laboratory for sixty students and another for thirty students, in addition to laboratories for honours degree work, rooms for staff, a workshop, photographic and instrument rooms, service rooms and three small research rooms. It continues to house the extensive museum collections in the fine room originally built for them. This block, however, could not provide enough room for the research work of the Department; consequently, a three-story building with 5,870 sq. ft. of floor space has been built on an adjoining site. On the ground floor the chief feature is two constant-temperature rooms to work from 0° to 40° C. The first floor contains a suite of laboratories, including an autoclave room and experimental theatre, a radioactive isotope room and research laboratories for the Agricultural Research Council Unit of Embryology which is housed in the Department. The second floor includes, in addition to research rooms of various sizes, an instrument room and a cool room fitted for the maintenance of cultures of marine or freshwater aquatic animals. The whole new building can accommodate fifteen research workers.

Accessible to, but separate from, this building, an animal house for small animals had been built with a floor space of 3,000 sq. ft. This is of light construction and is specially designed to exclude rodents and insect pests so far as possible. The details of its design have been published elsewhere*.

The Physics Department has been responsible, in recent years, for teaching some 150 undergraduate students and, like the Chemistry and Zoology Departments, it now uses for its teaching and research a newly constructed block together with a part of the old Memorial Buildings. The former is incomplete and allows for expansion to at least double its present size. It is of red brick, rectangular in plan, with two floors and a flat roof. The upper floor provides teaching laboratories for at least seventy students and includes, in addition to a large general laboratory, a room for experiments in optics

* Hemmings, W. A., "The Design of Animal Houses". Collected Papers of the Laboratory Animals Bureau, 2 (1954).

Fig. 1. Botany–Forestry Building, Bangor

and two others for acoustics. More accommodation for research is provided on the ground floor, which is now used for work on nuclear magnetic resonance. Also on the ground floor are the pleasant departmental library and the staff common room.

The botany–forestry building is the largest, as well as the most ambitious in design, of the new buildings at Bangor (Figs. 1 and 2). Since the main frontage of the building stands only a few feet back from the main London–Holyhead road, a dominant consideration in its design was to exclude street noise. Because of this, on the south side of the building facing the road there are few windows and none of large size, except that lighting the main staircase; for the same reason, a large part of this side is occupied by corridors and hall spaces. At first sight, the distribution of windows might give the impression that the interior is poorly lit; but in fact all parts of the building have excellent lighting, particularly the top floor, which houses all the teaching laboratories of the Botany Department; this has a generous provision of roof lights as well as large windows on the north, east and west. The lecture rooms situated in the north-east corner of the building have no windows at all on the wall facing the main road, but are adequately lit as well as almost completely insulated from outside noise. The architect has thus successfully solved the problem of providing at the same time good natural illumination and freedom from noise on a not very easy site.

This is a red brick building on three floors. It has also a semi-basement which allows advantage to be taken of the differing levels of the front and back of the site. In addition, the flat roof is to be provided with two greenhouses, serving as additional laboratories for the physiological work of the Botany Department. Other greenhouses for departmental use are on an adjoining site. About a third of the floor space is allotted to the Forestry Department, the remainder to the Botany Department, which is responsible for training some 150 students, the majority eventually graduating in forestry, agriculture, or one of the pure sciences.

The most striking decorative feature of the building is the large entrance hall panelled with a great variety of ornamental hardwoods.

The Forestry Department, besides rooms for staff and two lecture rooms, has a laboratory for about twenty students, equipped for surveying and engineering drawing as well as for practical classes in forest botany and wood anatomy. There are a large library and reading room and a museum of corresponding dimensions which it is proposed to fill with a variety of exhibits, including dioramas illustrating forests under various systems of management. In addition, the semi-basement contains photographic dark-rooms, a large and well-equipped wood-working shop and a store for the tools, surveying instruments, etc., used by the forestry students in their practical training.

The Botany Department has on the ground floor a lecture room seating 120, a small museum, a

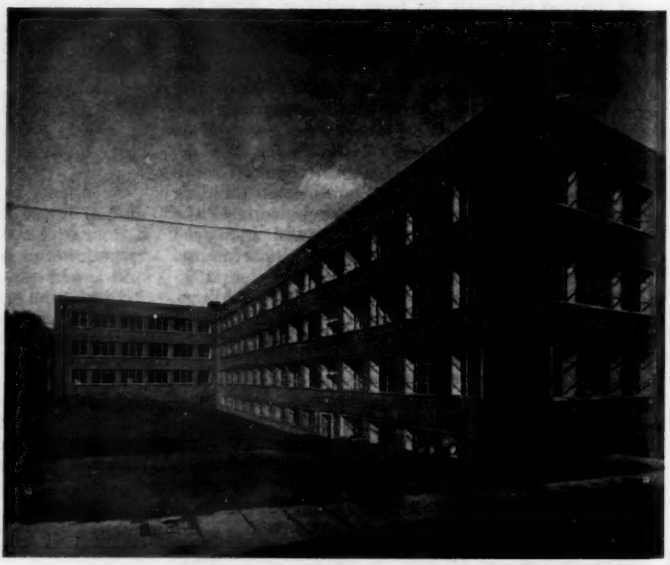

Fig. 2. Botany–Forestry Building, Bangor

herbarium and a research laboratory specially equipped for work on marine and freshwater algae as well as rooms for staff and postgraduate research workers. Further accommodation for staff and postgraduate students is provided on the first floor, which also houses a small lecture room (seating seventy), the library and separate reading room.

On the top floor, which is wholly allotted to botany, there are two large teaching laboratories for general botany, providing places for sixty-two and forty-eight students, respectively. Since these laboratories are placed back to back and divided only by swing doors, they can when occasion demands be treated as a single unit. In these and in the small honours work laboratory (capacity sixteen students) there is ample space for demonstrations and (as in the forestry laboratory) each student is provided with an adjustable 'Anglepoise' lamp and a microscope lamp made to the Department's specification. Only a limited amount of overhead lighting is provided. The small laboratory for advanced mycology is similarly designed.

Also on the top floor are the laboratories for plant physiology. The teaching laboratory, holding sixty students, resembles a well-equipped chemical laboratory. The benches are provided with electrically heated water baths, but not gas, and there are vacuum and compressed air points. There is overhead fluorescent lighting and an adjacent balance room. Near by is a small research laboratory and preparation room.

The semi-basement, in addition to housing the Forestry Department's wood-working shop and instruments store previously mentioned, provides the Botany Department with two photographic darkrooms, a general photographic room, a workshop and sorting room and two constant-temperature rooms.

In his introductory speech at the opening ceremony, Lord Kenyon, president of the College, said that the completion of the new science buildings was an event second in importance only to the opening of the College itself. He expressed the thanks of the College to the University Grants Committee for the financial support which had made the post-war building programme possible.

Sir Keith Murray then spoke of the significance of the occasion as marking the increasing importance of science, and especially of biology, to-day. That the College had found it necessary to increase the accommodation for all its science departments and not only for some of them illustrated the breakdown of the lines of demarcation between the different sciences and the need for training in the fundamental sciences as the basis of all scientific education.

After emphasizing the growing importance of the biological sciences because of the rise in world population and the consequent pressure on food supply and other natural resources, Sir Keith went on to say that the duty of a university is to turn out men and women with minds which are trained and not merely stored with facts; this training should be carried out not merely by formal instruction in the lecture room and laboratory, but by informal contacts between the students and the more mature minds of their teachers, as well as by the contacts of student with student in daily work and extra-curricular activities. The latter are as valuable a part of a university education as the work covered by the examination syllabus.

Sir Keith Murray was thanked by Sir Emrys Evans, principal of the College, and finally the College's gratitude to the architect and the contractors was expressed by Sir Wynn Wheldon and Lady Artemus-Jones, vice-presidents.

PLANT GROWTH SUBSTANCES

THIRD INTERNATIONAL CONFERENCE

THE Third International Conference on Plant Growth Substances was held at Wye College (University of London) during July 17–22. The organizer was Prof. R. L. Wain, head of the Department of Chemistry in the College and director of the Agricultural Research Council Unit for Plant Growth Substances and Systemic Fungicides. D. F. Wightman acted as conference secretary.

The emphasis of the papers and discussions was on the biochemical aspects of the subject but not confined, as in the preceding conference at Lund in 1953, to considerations of the relationships between chemical structure and biological activity. Although two whole sessions were devoted to this topic, the remaining four on the natural auxins, auxin metabolism and mechanism of action promoted the more vigorous discussions.

The two years that have elapsed since the Lund Conference have seen the almost universal adoption of paper partition chromatography as a tool in the study of naturally occurring plant growth substances. The opening session of the Conference clearly demonstrated how valuable this new tool has been in tackling the involved problems of the nature of the natural auxins. Dr. J. P. Nitsch (Harvard University), in a systematic study of extraction, separation and assay methods, has revealed the dangers of using ether as a solvent for extractions in the cold since enzyme activity may still persist in this solvent. Absolute methanol or ethanol are much to be preferred. He also demonstrated how different solvents could change the pattern of active substances extracted, thus illustrating the dangers of too narrow an application of stereotyped techniques. Another, until recently unsuspected, danger was the use of ammonia as a component of the chromatographic solvent for the separation of acid growth substances. Considerable hydrolysis of certain substances may occur during the running of the chromatogram. This presumably accounts for the interconversions of neutral auxin precursors extracted from a variety of plant tissues by Dr. J. A. Bentley and Mr. S. Housley (University of Manchester). Dr. Nitsch also introduced a new assay technique, using segments from the first internode of oat seedlings. This he claims has a sensitivity greater than that of the oat coleoptile curvature test and can measure quantities of indole-3-acetic acid of the order of 0·001 μgm. This makes it possible to study small quantities of tissue such as apical meristems, 200

mgm. of which is sufficient to allow an accurate assay. In a number of papers and in the discussions which followed, the reliability of the usual colorimetric tests for indole compounds came under review. Both Dr. Nitsch and Dr. A. J. Vlitos (New York) have perfected reliable quantitative methods for measuring colour intensity of spots on paper chromatograms, allowing accurate estimations of indole compounds when present in relatively high concentrations.

Chromatographic techniques in the hands of Prof. Hans Söding and Dr. Edith Raadts (Hamburg) have been turned to the solution of the old enigma of the nature of auxin in the oat coleoptile. Indole-3-acetic acid was found in quantity in the diffusates from apex and base of that organ together with an unidentified growth-promoting substance. Two growth inhibitors and a precursor of indole-3-acetic acid were also isolated. Similar techniques have been employed at Wye College to study changes in growth substance content of the various organs of germinating seedlings (Miss P. M. Cartwright, Mr. J. T. Sykes and Prof. R. L. Wain). The results point to the conclusion that indole-3-acetic acid has no part to play in the germination processes themselves but is important in the growth of the young shoot. One interesting point was the detection of indole-3-carboxylic acid in these seedling extracts, a compound which might be derived from indole-3-acetonitrile by α-oxidation, as shown in the contribution of Mr. R. C. Seeley and his collaborators (Wye College).

Exciting discoveries of new growth substances from the endosperms of seeds were announced by Prof. F. C. Steward (Cornell University). Using a new technique of plant tissue culture, permitting the study of free-floating cells, the separate effects of natural growth substances on cell division, cell expansion and cell differentiation could be followed. Four nitrogenous substances, highly active in stimulating cell divisions, have been isolated from coconut milk by heavy-metal precipitations. One of these substances has been identified unequivocally as 1-3-diphenyl-urea. Its action has been confirmed on carrot, artichoke and potato tissue. Nitrogen-free substances with a similar action have been extracted from immature *Aesculus* fruits and from coconut milk. These substances belong to the general class of leucoanthocyanins, although their final identity is not yet known. It seems, therefore, that the power of stimulating the cell to divide is not the sole prerogative of any single molecule.

The sessions on the relationships between chemical structure and biological activity in the auxins received the greatest share of the formal papers. Prof. H. Veldstra (University of Leyden), in a review of recent advances, directed attention to a range of new substituted benzoic acids the structure-activity relationships of which point strongly to a physicochemical action of the molecule acting via its stereochemical relationships rather than to a purely chemical combination with a receptor at specific reactive points in the molecule. This was to some extent emphasized by the results of Dr. L. C. Luckwill and D. Woodcock (Long Ashton, Bristol), who pointed out that the effects of chlorine substitution in the 2-naphthoxyacetic acids would, on a chemical combination hypothesis, require the unlikely postulate of a specific combination of receptor with five separate points in the auxin molecule. Prof. Veldstra pointed to another interesting development, namely, the discovery that the carboxymethyl-N : N-dialkyldithiocarbamates are active as auxins. This is the first case of an active compound not possessing an unsaturated ring and adds considerable support to Veldstra's physico-chemical hypothesis of auxin activity. Previous work had strongly suggested that in the optically active propionic acid series of synthetic auxins (+) forms were almost always active, whereas the corresponding (−) forms were inactive or auxin antagonists. The work of Dr. J. M. F. Leaper (Ambler, Pennsylvania) and Dr. B. Åberg (University of Uppsala) with the naphthalene derivatives showed this to be an over-simplification, since both forms can be auxins, their relative activities depending on the test plant employed. Prof. R. L. Wain and colleagues (Wye College) described extensive experiments in the structure-activity relationships of homologous series of ω-(2,4-dichlorophenoxy)-alkane carboxylic acids, amides and nitriles. It was shown that the alternation of activity with increasing side-chain length in both acids and amides could be correlated with the appearance of 2,4-dichlorophenoxyacetic acid in the tissue, presumably produced by the β-oxidation of the side-chain. With the nitriles, all homologues showed activity, suggesting the hydrolysis of both —CN and —CH_2.CN groups to —COOH. A similar alternation of activity in the tomato ovary test was shown by Dr. L. C. Luckwill and D. Woodcock (Long Ashton, Bristol) for the 2-naphthyloxy- series of acids, but here β-oxidation was blocked completely by chlorine substitution in the 3 position in the ring, only the acetic acid being active.

The controversial questions concerning the structure–activity relationships of 'anti-auxins' in root growth were discussed by Dr. B. Åberg (University of Uppsala) and Prof. Hans Burström (University of Lund). Dr. Åberg demonstrated that much of the conflicting evidence from previous work may have been due to the use of different test materials, since wheat roots are much more sensitive and more easily stimulated by anti-auxins than flax roots. In the phenoxy-*iso*-butyric acids and some other similar anti-auxins which stimulate root growth, para-substitution in the ring was shown greatly to increase activity. The dangers of using gross elongation of roots as a measure of activity in these compounds was pointed out by Prof. Burström from a study of the interactions of β-naphthoxyacetic acid (inhibiting auxin), three of its chloro-substituted derivatives, indole-3-acetic acid and α-(3-indole)-*iso*-butyric acid (anti-auxin). There seems to be two phases in root cell elongation on which different compounds may have different actions, may also show different mutual interaction patterns or may not interact at all. The great importance, therefore, of paying due attention to the heterogeneity of the cell elongation mechanism in structure–activity studies was heavily stressed. Out of these considerations active discussion turned on the role of indole-3-acetic acid in normal root growth. No measure of agreement was reached.

Much attention was paid to theoretical considerations underlying structure–activity relationships. Dr. J. van Overbeek (Modesto, California), in a consideration of the properties of a group of suspected auxin antagonists, the maleimides, and a new class of plant growth inhibitors, the phosphenoxides, showed that a close relationship exists between activity and lipoid solubility and suggested, therefore, that ease of penetration through protoplasmic membranes might explain structure–activity relationships. Drs. H. Linser and K. Kaindl (Linz) discussed

the relationships of molecular shape and size to stimulatory and inhibitory activity in oat coleoptile growth. An extensive mathematical treatment of the curves relating applied concentration to growth response to single substances and mixtures, based on the concept of molecules competing for various receptor 'holes' at growth centres in the cell, was subjected to some criticism by the physiologists. It was felt that such a simple concept ignored both the fundamental differences in action which must exist between auxins and toxic inhibitors such as eosin and also the possibility of metabolic interactions. This view was supported by the finding of Prof. L. J. Audus and Miss R. Thresh (Bedford College, London) that the auxin antagonist 2,3,5-tri-iodobenzoic acid may exert its physiological actions by lowering dramatically the level of endogenous indole-3-acetic acid in plant tissues. The application of the methods of enzyme kinetics to the study of auxin–anti-auxin interactions, as developed by Prof. J. Bonner (California Institute of Technology), came under full discussion. It was agreed that the technique had its uses, provided it was applied with the greatest circumspection.

Some four or so papers were concerned with the metabolism of indole-3-acetic acid and related compounds in the plant. In a critical review of the biogenesis of this compound, Dr. S. A. Gordon (Lemont) considered new data bearing on the pathways of its production from tryptophan. The current view is that it may be degraded to indole-3-acetaldehyde via either tryptamine or indole-3-pyruvic acid and thence via the aldehyde to indole-3-acetic acid. Alternatively the pathway suggested is a branching at the iminopropionic acid to yield the acetonitrile, which is then hydrolysed to indole-3-acetic acid via the acetamide. However, various considerations were discussed which indicate that the above specific pathways, though potentially operative in plants, do not normally function in indole-3-acetic acid formation. The hypothesis was presented that tryptophan goes to indole-3-acetic acid via a sequence analogous to the pyruvate dehydrogenase mechanism, that is, indole-3-pyruvic acid to indole-3-acetic acid through the acyl lipoate directly or through the coenzyme A ester. The differing abilities of various plant species to hydrolyse indole-3-acetamide and indole-3-acetonitrile to indole-3-acetic acid were clearly demonstrated by Mr. R. C. Seely and collaborators at Wye College. Thus the amide is extensively converted to the acid by pea, tomato and maize tissue but not by wheat and celery, whereas the nitrile is converted by wheat and maize but not by the other tissues. The fate of indole-3-acetic acid fed in high concentrations to tissues was discussed by Dr. A. W. Galston (California Institute of Technology), who showed that a fraction may be actively bound to cytoplasmic proteins. The greater portion, however, is oxidized by the action of a peroxidase system induced by the high indole-3-acetic acid concentrations applied. Both the peroxidase and the peroxide-producing moieties of the total system are so induced. It was suggested that this phenomenon accounts for the normal cessation of cell elongation and the subsequent onset of lignification by the oxidation of lignin precursors of the eugenol type by this induced peroxidase system.

Little attention was given to the role of indole-3-acetic acid in physiological processes in plants. Prof. P. Larsen (University of Bergen) presented data on geotropic responses of roots pointing to the validity of the classical Went–Cholodny theory. The role of auxin in the flowering of short-day plants was discussed by Dr. A. J. Vlitos (Boyce Thompson Institute, New York). Contrary to current theories, indole-3-acetic acid levels in short-day photoinduced plants of Biloxi soy bean and Maryland Mammoth tobacco are much higher than in non-induced plants.

The final session of the conference was devoted to papers and discussion on the mechanism of auxin action. Prof. J. Bonner (California Institute of Technology), in an extensive investigation into the osmotic relations of growing oat coleoptile segments, returned to the conclusions put forward a quarter of a century earlier by Heyn, that the ultimate action of auxin must be in the cell wall. In an elegant series of experiments in which segments were treated with indole-3-acetic acid and then prevented from growing by osmotic means, he demonstrated a persistent effect on wall properties independent of any effect arising as a result of growth. Water permeability was dismissed as a possible factor, from studies with deuterium-labelled water. The results of extensive studies on auxins and absorptive processes were presented by Prof. G. E. Blackman (University of Oxford). The actions of 2,4-dichlorophenoxyacetic acid on growth and absorption of nitrogen, phosphorus and potassium are not obviously related. *Lemna minor* and *Salvinia natans* differ considerably in their responses. Radioactively labelled 2,4-dichlorophenoxyacetic acid is rapidly taken up by these plants, but after four hours a loss from the tissues is observed. The temperature sensitivity of this loss suggests that it is not an exchange action but an active export of the auxin molecule. Pre-treatment of plants with very dilute solutions of the acid considerably reduces subsequent uptake, giving a possible explanation of the reduced sensitivity of such pre-treated plants to toxic levels of 2,4-dichlorophenoxyacetic acid treatment. The role of coenzyme A in growth processes mediated by auxin was discussed by Dr. A. C. Leopold (Purdue University, United States). Most striking was the effectiveness of supposed anti-auxins, for example, 2,3,5-tri-iodobenzoic acid, 2,4-dichloranisole and coumarin, in blocking the effective —SH groups in the coenzyme. The inadequacies of a previous theory of growth substances action based on coenzyme A esterification were discussed in the light of new findings. Prof. T. A. Bennet-Clark (King's College, London) presented a new theory to explain auxin action on cell wall extensibility. Evidence was presented that this extensibility might be closely bound up with the state of pectic substances in the growing cell wall and the nature and intensity of the cross-linking forces between the molecules. Further evidence suggested that methylation of these pectic substances and also their relationships with calcium ions might play a part in wall changes and that choline and choline-esterase might be involved. The marked inhibiting action of indole-3-acetic acid on choline esterase activity adds support to these views. Other views on possible mechanisms were expressed during the conference. Prof. H. Veldstra directed particular attention to nucleic acid metabolism, an aspect so far neglected in auxin studies. Prof. F. C. Steward made a similar plea for nitrogen metabolism.

The papers given at the conference are to be published in a special volume which, it is hoped, will appear well before the end of the year.

L. J. Audus

RELATION OF GENETICS TO POPULATION STUDIES

A WELL-ATTENDED joint session of Sections D, I and J (Zoology, Physiology and Psychology) of the British Association took place in Bristol on September 2, the general topic being "Genetics and Medicine".

In the opening paper, Dr. H. Grüneberg (University College, London) discussed the use of "Inherited Diseases in Animals as a Tool in Medical Research". The laboratory rodents have provided a large number of inherited conditions, including many with close counterparts in man. Many of these are caused by single genes; but equally important are inherited diseases conditioned by an array of genes which occur in a high frequency in some inbred strains, but are rare or absent in others. The use of this material opens up certain important fields of research which are inaccessible in man himself. The majority of inherited diseases and anomalies due to single genes arise in early development, and as early human embryos with the initial phases of such anomalies are scarcely ever available for study, a step-by-step investigation of abnormal development is entirely dependent on animal material.

Direct observation shows that the mechanisms underlying abnormal development are often quite different from those of classical pathology. For example, a reduction of the vertebral bodies with absence of the odontoid process of the axis in a mouse mutant is due to an early degeneration of the notochord. Widespread skeletal anomalies associated with the gene for congenital hydrocephalus in the same animal are due to general reduction in size of the mesenchymal skeleton as it is formed, and threshold mechanisms determine the absence of some elements, fusions between others, etc. In a third instance, anomalies of the vertebral column, again in the mouse, are traceable to a faulty distribution of mesenchymal material, too much being used for the intervertebral disks and too little for the vertebræ themselves.

The pathology of development is thus a new field entirely dependent on animal material. The discovery of several inherited types of deafness in the mouse is likely to assist in the understanding of the pathology of human deafness, which is greatly hampered by technical difficulties not encountered in animal material. Important progress has been made by the use of resistant and susceptible strains of animals in analysing the physiological basis for disease resistance. The use of animal material for studying diseases of old age, so familiar in cancer research, was illustrated by amyloid degeneration and cystic kidney disease in a certain strain of mice and its absence in others; what could scarcely have been discovered in man is the fact that this inherited tendency to amyloidosis can be almost completely suppressed on certain low-protein diets.

In a paper on the "Causation in Mental Deficiencies", Dr. J. A. Fraser Roberts (London School of Hygiene and Tropical Medicine) pointed out that gene differences in certain rare types of mental deficiency have provided important general information; for example, the first estimate of an autosomal mutation-rate in vertebrates was made with tuberose sclerosis (epiloia). There is evidence that some modest proportion of severe mental deficiency, in addition to a few rare special types, is determined by recessive genes. The great bulk of mental deficiency, however, is a heterogeneous collection the causation of which presents difficult problems. The most useful division of the mental deficiencies is into two groups which may be ascribed to major errors of development, whether genetic or non-genetic. Mild defect shows the signs of some measure of multifactorial determination, together with multiple environmental influences. In spite of the difficulties of measurement, the evidence seems to point to little real underlying overlapping. The incidence of severe defect among the brothers and sisters of those mildly affected is little if at all greater than in the general population. Conversely, apart from the sibs also severely affected, the intelligence of the sibs of those severely affected is little lower on the average than in the general population. Much, or possibly all, the apparent lowering is an artefact due to the methods of sampling. A substantial part of the resemblance between relatives in level of intelligence (including mild mental deficiency) is probably environmental.

Penrose's studies and Dr. Fraser Roberts's own yield a correlation between first cousins which is double what it should be, given the correlation between sibs. It seems reasonable to conclude that while the genes in common are reduced to one-quarter in cousins as against sibs, environmental similarities fall off much more slowly as relationship becomes more remote. It is possible that some major non-genetic causes affecting intelligence adversely may be identified. For example, there is the definite lowering in twins, as found in the Scottish survey. There is also the evidence that prematurity is much commoner among high-grade and borderline defectives than in the general population.

Dr. E. T. O. Slater (Genetic Unit, Institute of Psychiatry, University of London) gave a brief general report on "Work on Twins in Psychological Medicine", in which he reviewed particularly twin studies on the causes of schizophrenia and of criminality; in the latter, earlier studies had suggested a predominant influence of heredity; but in more recent work, factors like early background and family tradition, special opportunities and temptations have now emerged as significant causes. In Dr. Slater's own work (jointly with Mr. James Shields) on the causes of 'neurosis', the comparison between monozygotic and dizygotic twin pairs has produced evidence that the tendency to neurosis is, at least in part, under genetic control.

The main emphasis of the work was, however, on the environmental causes of the breakdown. These were studied through the differences which were found between the partners of monozygotic twin pairs, the differences being caused by the inter-twin relationship (one twin tending to take on more of the leadership, etc.), the relationship with parents, the marital relationship, by differences in occupational stress and of physical health, and finally by differences in psychological stress other than those covered above. In nearly all cases, causes are multiple, though very often a single factor can be picked out as the most important. Generally, Dr. Slater considers that the causes of neurotic illness are intelligible at a commonsense level and do not seem to require recondite hypotheses. Among causes operating from early in child life, those which persist for years (for ex-

ample, the type of training) seem to be the most important.

Prof. L. S. Penrose (Galton Laboratory, University College, London) demonstrated in his paper on "Mutation and Parental Age" that human material may in certain cases yield results superior to those usually obtained from experimental animals. The spontaneous mutation-rates of a number of ('dominant') human genes have been estimated by direct observation of freshly arising cases, that is, of abnormal children born of normal parents. In other cases, an indirect method has been used which is based on the supposition that elimination by selection of a gene with deleterious effects must be balanced by newly arising mutations, the overall frequency of the condition remaining approximately constant.

Additional information about possible causes of mutations has now been obtained from a consideration of parental age. For example, if a certain gene is particularly sensitive to ionizing radiation to which parents are exposed throughout their lives, mutations at that locus will be proportional to parental age such that the trait will be twice as common among offspring of parents aged forty as among those with parents aged twenty years. Looked at in another way, the parents of children carrying newly mutated genes will be older than the average parent. Some evidence (unfortunately from maternal ages only) of an increase of mutation-rate with age comes from microphthalmia, and there is less complete evidence of an effect of both paternal and maternal age in the case of epiloia and retinoblastoma. The incidence of achondroplasia (born of normal parents and hence presumably due to a new mutation) depends strikingly on the age of the father, but there seems to be little or no effect of the age of the mother; in the latter case, a possible interpretation is that, while the epiloia locus is sensitive to natural radiation, the achondroplasia locus is sensitive to agencies specially active at some stage in cell division, perhaps chemical mutagens. The relative absence of cell division in the female germ track, as compared with the male germ track, would explain the lack of independent maternal effects. The dependence or otherwise of mutation-rate on parental age thus affords some information on possible causes of 'spontaneous' mutations not so far obtainable from data on spontaneous mutations in animals.

The concluding paper, by Dr. C. O. Carter (secretary, Eugenics Society), dealt with "Genetics and Child Health". In recent years, deaths from diseases of childhood due to environmental causes (mainly infections) have declined sharply. As a result, the groups of diseases mainly or partly due to genetical causes loom much larger. An indication of the changes in relative importance is given by the cause of death in two hundred consecutive children undergoing post-mortem investigation in a children's hospital in each of the years 1914 and 1954. The group of diseases caused by environment was more than two-thirds of the whole in 1914, but less than one-seventh in 1954; the group of diseases mainly genetical in origin was only one-fiftieth of the whole in 1914 but one-eighth in 1954; diseases of mixed causation were less than one-seventh of the whole in 1914, but more than a quarter in 1954, while diseases of unknown causation rose from less than a quarter in 1914 to nearly a half in 1954.

Looking to the future, Dr. Carter believes that, while the environmentally caused group of diseases will continue to fall, the diseases of mixed origin will probably be only slightly reduced by environmental measures. Reduction in the proportion of children born with genes predisposing to these disorders can only be achieved by reducing the average number of generations through which disadvantageous gene mutations can persist in the population. At the moment, such mutations are tending to last longer as new methods of treatment keep those affected alive to an age at which they can bear children. Probably the most ethically correct way of bringing about a reduction in the average number of generations a mutation persists is to enlist the co-operation of parents who are unlucky enough to carry major disadvantageous mutations, in planning to keep the number of their children below replacement-rate.

OBITUARIES

Prof. J. C. Flugel

Prof. John Carl Flugel died suddenly at his home in London on August 6. He was one of the few survivors of the small band of British psychologists who received their training at Oxford under William McDougall. McDougall's views on the nature of mind and the way psychological questions should be approached influenced nearly all that Flugel wrote; yet he himself succeeded in developing a wholly original attitude.

His earliest researches were carried out in the laboratory at Oxford, and dealt with such practical problems as intelligence testing, visual adaptation at night, the measurement of mental fatigue and the causes of the oscillations of attention. After his appointment as lecturer at University College, London, he remained for many years in charge of the experimental work in the Department of Psychology. His chief interest, however, lay in the deeper problems such as in those days were relegated to the somewhat dubious regions of psychoanalytic study and psychical research. He was the first professional psychologist to make a serious examination of Freud's early theories. These he endeavoured to re-interpret in terms of current British psychology. Thus, while the medical profession still looked askance at the novel and extravagant doctrines of the Freudian School, he did much to popularize their chief conclusions by recasting them in a more acceptable form. The outcome was a series of papers on psycho-analytical topics which appeared in various scientific journals, and were later collected and re-issued in book form.

Of his larger works, the first was "The Psychoanalytic Study of the Family" (1921), which attracted immediate attention. The most popular was probably his "Psychology of Clothes" (1930). "A Hundred Years of Psychology" (1933) presents an admirable historical review of the development of psychology from 1833 to the date of publication, and is still read as a regular text-book. The lucid style, the flashes of humour, the widespread sympathy and tolerance which distinguish all his writings were also a marked feature of his personal teaching, and endeared him to numerous students who came to his classes from all over the world.

In 1929 Flugel was made assistant professor, and retained this post until his retirement in 1944. A good deal of his time was spent in practical psychoanalytical work with patients and normal persons; and the results led to many valuable contributions to psychological and psychiatric theory. The more

important were embodied in his books on "Men and their Motives" (1934) and "Man, Morals, and Society" (1945). He served for some time as honorary secretary of the International Psychoanalytic Association; and in 1948 was elected chairman of the programme committee of the International Congress on Mental Health. Two years later he was appointed president of Section J (Psychology) of the British Association.

To the end of his life Flugel continued to give regular lectures at University College and to take an active part in the work of the British Psychological Society and its numerous committees. But his abiding work lies in his fruitful attempts to synthesize Freudian psychoanalysis with the orthodox tenets of British psychology as taught by Ward, Stout and McDougall.

Cyril Burt

Mr. Philip Lyle

Philip Lyle, who died on July 15, was the elder son of the late John Lyle, of Weybridge, and grandson of Abram Lyle, the founder of the sugar-refining company which was later amalgamated with Henry Tate and Sons to form Tate and Lyle, Ltd. He was born on November 26, 1885, and was educated at Rugby, in Switzerland and at University College, London. He later applied himself to statistical mathematics, which he put to very good use in the sugar industry.

As a director of Tate and Lyle, first at Plaistow refinery, Philip Lyle participated in raising the low thermal efficiency, poor scientific control and low output of the refinery until it held one of the foremost positions in the world. He paid special attention to losses incurred in sugar refining and consequently to methods of sugar analysis. In 1947 he was responsible for broadening the Company's outlook towards research and enlarging its research activities. As chairman of the Research and Development Committee he was invaluable in guidance and judgment.

Mr. Lyle's own scientific contributions were best known in refinery circles; but a few exceptions include "Heat of Solution of Sucrose", which explained discrepancies in heat balances in refineries. The "Sugar Industry" and "Constructions of Nomograms for use in Statistics" appeared in the *Journal of the Royal Statistical Society* and *Applied Statistics*, respectively. He was a notable member of both the Royal Statistical Society and its Industrial Applications Section, being one of the two secretaries and editors of the former and on the Editorial Committee of the latter. In 1944 he published "Regression Analysis of Production Costs and Factory Operations".

Philip Lyle was a director of the West Indies Sugar Co. of Jamaica, and Caroni, Ltd., of Trinidad. He made a special study of statistical treatment of agronomical problems. He was also a director of Colonial Yeast, Ltd., which had been founded by the Sugar Commission to produce cheap protein and vitamins (Thaysen's *Torula utilis*) needed in the Caribbean, from surplus cane molasses. The product could not find a market there or elsewhere, and the project was abandoned; but his faith in the necessity for protein production to supply under-nourished peoples was unfailing, and he read a paper on the subject before the Nutrition Society in 1950.

The Sugar Reorganization Act, 1936, was responsible for formation of Research Committees *A* and *B*, of which he was a member. The programme for *B* was largely that put forward by him and was adopted in part by the Colonial Research Committee. Other proposals were chemical research into by-product utilization and sucro-chemistry, which were implemented at the University of Birmingham under Sir Norman Haworth and later Prof. L. F. Wiggins. Physico-chemical research at the University of Bristol was financed first by the Commission and later by Tate and Lyle and the British Sugar Corporation.

Among unpublished work which has nevertheless been widely adopted and utilized is his "Analysis of Sugar Grists", in which he showed that the normal frequency curves allowed grists to be expressed in terms of mean aperture and coefficient of variation.

So much for his interests and work. What of the man? To meet Philip Lyle was to like him. To know him was to admire, respect and love him. His encouraging manner, his friendly approach, his sunny smile (the same to people in all walks of life) made everyone his friend, and effort on his behalf a pleasure; Browning might have altered the lettering of "Pippa passes". He leaves a widow, a daughter, two sons, one of whom is following in his footsteps, several grandchildren and innumerable friends.

H. C. S. de Whalley

Sir Francis McClean

Frank McClean was best known to the outside world as the great patron of aviation and the founder of amateur and naval flying in Great Britain. Born on February 1, 1876, and educated at Charterhouse, Clifton and Coopers Hill, he served with the Public Works Department in India during 1898–1902. After flying in two Gordon-Bennett balloon races in 1907–8, he flew with Wilbur Wright at Le Mans in the latter year. He bought land in the Isle of Sheppey for his early flying experiences on heavier-than-air machines and lent aircraft to the Admiralty so that naval officers could learn to fly. After some pioneering work in submarine photography, he caused some sensation by flying up the Thames in a seaplane, passing between the upper and lower parts of the Tower Bridge and under London Bridge. He joined the R.N.A.S. on the outbreak of the First World War, served on Channel patrol and then became chief instructor at Eastchurch. When the R.A.F. was formed he took a commission, but resigned in 1919.

McClean's other great interest lay in astronomy; in this he was influenced by his father, Dr. Frank McClean. He organized two eclipse expeditions, to Flint Island in 1908 and to Port Davey in Tasmania in 1910. He also joined an expedition led by Sir Norman Lockyer to Vavau Island in 1911. He was a joint founder of the Norman Lockyer Observatory on Salcombe Hill, Sidmouth, serving under his friend, Sir Richard Gregory, on its council. The Frank McClean Dome and the twin telescope and sidereal clock which it houses bear further witness to his generosity. His 21-in. siderostat, bought for his eclipse expeditions, was presented by him to the Cambridge Observatories. With his brothers, he was a generous benefactor also to the Coins and Manuscripts Departments of the Fitzwilliam Museum, Cambridge. Other social activities are reflected in his holding the office of High Sheriff of Oxfordshire in 1932 and the presidency of the Royal Aero Club for two spells. He was the senior member of the Royal Astronomical Society Club, and was much loved by a wide circle of friends in flying and astronomical circles. He died on August 11 after a long illness, leaving a widow and two daughters.

F. J. M. Stratton

NEWS and VIEWS

Chemistry at Nottingham : Prof. F. E. King, F.R.S.

Prof. F. E. King, who has recently resigned the Sir Jesse Boot chair of chemistry in the University of Nottingham to become director in charge of research at British Celanese, Ltd., carried out his earliest researches with Prof. J. R. Partington in the University of London, mainly on inorganic and physical chemical subjects. He then went to Oxford, where he became in turn demonstrator and lecturer in the Dyson Perrins Laboratory, and also lecturer in organic chemistry at Magdalen and at Balliol Colleges. His work at Oxford covered a wide field ; but particularly noteworthy, in chronological order, were the long series of papers which Sir Robert Robinson and he published on the chemistry of eserine (physostigmine) and on laudanosine ; his work on potential chemotherapeutic agents, particularly derivatives of quinoxalines, iminazoles, cinnolines and arylamines ; and his work on the structure of extractives from hardwoods. This very difficult branch of natural-product chemistry has been his major interest during recent years, and he has obtained some conspicuously successful results, for example, the elucidation of the structure of ferreirin and homoferreirin obtained from the heartwood of *Ferreirea spectabilis*. British Celanese, Ltd., is providing facilities for the continuation of this work under Prof. King's supervision. He was elected to the chair at Nottingham in 1948 and to fellowship of the Royal Society in 1954.

Prof. A. W. Johnson

Dr. A. W. Johnson, who succeeds Prof. King at Nottingham, received his early training at the Imperial College of Science and Technology, London, after two years of preliminary industrial experience. He remained at the Imperial College during 1936–42, his research work being chiefly on the synthesis of vitamin A. For the next four years he was research chemist at the Dyestuffs Division of Imperial Chemical Industries, Ltd., where he worked mainly on the chemistry of acetylene, which was then a rapidly developing subject and upon which he wrote a two-volume treatise that appeared in 1946 and 1950. In 1946 he went to the University of Cambridge, where he was appointed assistant director of research and, later, University lecturer in chemistry, and was also elected Fellow and Steward of Christ's College. His work at Cambridge with Sir Alexander Todd has been mainly on the chemistry of the tropolones and on the constitution of the deeply coloured compounds isolated from certain species of aphids, and later upon the structure of vitamin B_{12}. The work on this vitamin has been carried out in collaboration with the chemical staff of Glaxo Laboratories, Ltd., and ultimately with the help in the crystallographic field of Dr. Dorothy Crowfoot Hodgkin and others ; all the main points in the structure of this vitamin have thus now been elucidated (see *Nature*, August 20, p. 325). Dr. Johnson was awarded the Meldola Medal of the Royal Institute of Chemistry in 1946, and was Tilden Lecturer of the Chemical Society in 1953. Prof. King's resignation has deprived the University of Nottingham of an outstanding teacher and research worker ; but the University is indeed fortunate in securing, in Dr. Johnson, a successor who also possesses this invaluable combination of qualities.

Veterinary Pathology at Liverpool : Prof. D. L. Hughes

Mr. D. L. Hughes, head of the Veterinary Science Division of Messrs. Boots Pure Drug Co., Ltd., has been appointed to the chair of veterinary pathology in the University of Liverpool in succession to Prof. R. E. Glover, who has become principal and dean of the Royal Veterinary College, London. Prof. Hughes is well known even beyond the confines of his own profession, both as a research bacteriologist and administrator. Born in 1912, he studied at the Royal Veterinary College and obtained the diploma of membership of the Royal College of Veterinary Surgeons in 1934 ; two years later he was awarded the diploma in bacteriology of the University of London, and more recently the fellowship of the Royal College. Being keenly interested in research and particularly in the bacteriology of animal disease, Hughes quickly established a reputation for integrity and accuracy at the bench and in the written and spoken word. Although he is probably best known for his researches into bovine mastitis, undertaken principally while on the staff of the Agricultural Research Council's Field Station at Compton, and later at the veterinary laboratories of Messrs. Boots Pure Drug Co., Ltd., his published works command wider horizons and are not confined to bacteriology alone. Outside the laboratory he brings to the roles of administrator, lecturer and committee man the attribute of a quiet and direct manner ; to the British Veterinary Association he gives much time and energy as an active member of its Council and as chairman of the editorial committee of the *Veterinary Record*. His many friends and colleagues will wish him the best of good fortune in his new appointment.

Council of Scientific and Industrial Research, India : Prof. M. S. Thacker

Prof. M. S. Thacker has been appointed director of the Council of Scientific and Industrial Research, India, in succession to the late Sir Shanti Bhatnagar. Born on December 3, 1904, he received his early education at Ahmedabad and Bombay, and graduated in engineering from the University of Bristol in 1927. He worked as electrical engineer with Bristol Corporation until 1931. He then joined the Calcutta Electric Supply Corporation and served there as a senior technical officer until 1947. In that year he joined the Indian Institute of Science, Bangalore, as head of the Power Engineering Department, and in 1949 he was appointed director of the Institute. Prof. Thacker is a member of several learned scientific and professional bodies in India, the United Kingdom and the United States. He has been associated as delegate with the International Commission on Large Dams, the International Conference on Large Electricity Systems, Paris, the World Power Conference, the World Metallurgical Congress and the Unesco Advisory Committee on Arid Zone Research ; at the New Delhi session in October 1954 he was elected chairman of the Committee on Arid Zone Research. Prof. Thacker has served on the Board of Scientific and Industrial Research and the Board of Engineering Research of the Council of Scientific and Industrial Research, India. In the Republic of India Day honours on January 26, 1955, Prof. Thacker was the recipient of the award of Padma Bhushan.

The British Institution of Radio Engineers: Premiums for 1954

The British Institution of Radio Engineers has awarded the following premiums for papers on the subjects indicated, published in the *Journal* of the Institution during 1954: *Clerk Maxwell Premium* (the premier award of the Institution), to F. N. H. Robinson (Clarendon Laboratory, Oxford), microwave shot noise in electron beams and the minimum noise factor of travelling-wave tubes and klystrons; *Heinrich Hertz Premium*, to Dr. T. B. Tomlinson (formerly of the University of Southampton), partition components of flicker noise; *Louis Sterling Premium*, to L. H. Bedford (Marconi's Wireless Telegraph Co., Ltd.), problems of television cameras and camera tubes; *Sir J. C. Bose Premium*, to S. Deb (Institute of Radio Physics and Electronics, University of Calcutta), the decay of emission from an oxide-coated cathode due to adsorption of matter liberated from the anode; *Brabazon Premium*, to J. W. Jenkins, J. H. Evans, G. A. G. Wallace and D. Chambers (A. C. Cossor, Ltd.), a high-definition general-purpose radar; *Marconi Premium*, to W. T. Brown (British Telecommunications Research, Ltd.), some factors in the engineering design of very-high-frequency multi-channel telephone equipment; *Leslie McMichael Premium*, to Dr. G. N. Patchett (Bradford Technical College), a critical review of synchronizing separators, with particular reference to correct interlacing; *Students' Premium*, to R. W. Walker (King's College, Newcastle upon Tyne), an electronic random selector. Premiums have also been awarded to the following authors of papers read at the Industrial Electronics Convention, held at Oxford in July 1954: P. Huggins (Sargrove Electronics, Ltd.), statistical computers as applied to industrial control; C. W. Miller (Metropolitan-Vickers Electrical Co., Ltd.), industrial radiography and the linear accelerator; K. Kandiah and D. W. Chambers (Atomic Energy Research Establishment), multi-electrode counting tubes; J. L. Thompson (J. Langham Thompson, Ltd.), wire strain-gauge transducers for the measurement of pressure, force, displacement and acceleration; and M. T. Elvy (Redifon, Ltd.), electronic heating and the woodworking industry.

The Rubber-Stichting

The Rubber-Stichting (Rubber Foundation), established in 1936 with headquarters in Delft, is one of several research organizations operating in Europe and in the Far East in the interests of natural rubber. Financed by means of a cess levied on rubber produced in Indonesia, the recently announced intention of the Indonesian Government to remove the Foundation to Bogor has come as a severe shock to those interested in research on rubber. The staff, numbering more than two hundred, show little inclination to emigrate, and the possibility of the work in progress being stopped must be faced. The Rubber-Stichting has been engaged in fundamental research for long enough for its work to have won world-wide recognition. It is impossible here even to mention all of it; but of particular significance is its work in the field of latex, which, as a result, can now be used for the direct preparation of chlorinated rubber, rubber hydrochloride, cyclized rubber, and even ebonite. The preparation of reinforced rubber by the formation in the latex of synthetic resin complexes has been of particular interest from both the theoretical and practical points of view. In the laboratories at Delft pilot-plant research has been carried out on flame-resistant latex foam and rubber hydrochloride monofilaments; asphalt-rubber compositions for roads have been developed, a fleet of cars has been used for road-testing experimental tyre compositions, and cement-latex compositions for flooring have been studied. Fundamental investigations have been undertaken relating to vulcanization, abrasion, and the permeability of rubber. It is interesting to recall that out of the fifty papers accepted for presentation at last year's International Rubber Technology Conference, four emanated from the Rubber-Stichting.

A great deal of success has been achieved in publicizing the advantages and possibilities of rubber among technical men in other industries, in the education of rubber technologists, and in the holding of international symposia and conferences on different aspects of rubber technology. An efficient documentation centre for rubber is maintained, especially noteworthy for its work on correlation of rubber patents. In this field it has worked in close co-operation with the Intelligence Division of the Research Association of British Rubber Manufacturers, in which connexion mention must be made of its share in preparing and maintaining the International System for Classification of Rubber Information, the secretariat of which is at Delft.

Education in East Africa

Four years ago the Nuffield Foundation showed its interest in African education by sponsoring, jointly with the Colonial Office, the Jeffery and Binns Missions. It has now given further assistance to the education of Africans by making a grant of £50,000 towards the work of the Institute of Education at Makerere College, Uganda. A fifth of this sum will provide research accommodation and other facilities for the work of the Institute, while the balance forms an endowment fund enabling a Nuffield Research Fellow to pursue some line of educational study important to East Africa. In choosing the subject of the first research project, it was borne in mind that the Binns Mission had directed attention to the need for better courses in vernacular languages and English in the primary schools of East Africa, and advocated a much earlier start in the teaching of English than hitherto. But little is known about the best methods of teaching English to the children of East Africa, and an imperfect knowledge of the language holds up their education in all subjects well into the secondary school. After consultation with the Directors of Education of East Africa, and with their unanimous support, it has been agreed to devote the first few years of the Nuffield grant to an attack on problems of teaching English and the teaching of other school subjects in English.

Research on the Tropical Swamps of East and Central Africa

The Nuffield Foundation has given £21,900 for a four-year scheme of research on the biology of tropical swamps, to be directed by Prof. L. C. Beadle, professor of biology in Makerere College, Uganda. The area covered by swamps in East and Central Africa is enormous. In them are accumulating a large proportion of the plant nutrients washed in from the surrounding land which are being preserved under anaerobic conditions. Exploitation by drainage and dry cultivation has begun; but this is not the

only, nor, in the long run, necessarily the best method, since the organic matter is rapidly oxidized and the conditions under which it accumulates are destroyed. Wet cultivation of suitable crops (for example, rice) or use of the nutrients for fish culture are possible alternatives. But too little is known about the chemistry and biology of swamps and of the changes which occur on drying. It is the purpose of this scheme to provide information which may assist in framing a long-term policy. The main chemical and microbiological transformations in the water-logged material, the ecology of the swamp vegetation, the biology of the oligochæte worms and other invertebrates and their part in the processes of decomposition, the adaptation of fish to swamp conditions, and the scarcity in untouched swamps of the principal malarial mosquito, *Anopheles gambiae*, are some problems which require investigation. All of them are of practical importance; but there are some aspects which are of fundamental interest—for example, the adaptations to a predominantly anaerobic environment. Work has already been started by Prof. L. C. Beadle in the zoological field and in the botanical field by Dr. Edna M. Lind, reader in biology at Makerere College, and the East Africa Malaria Research Institute has been collaborating. With the new Nuffield grant it is now possible to employ a chemical microbiologist and a zoologist from Europe, and two graduates from Makerere College.

West African Tsetse Flies

THE taxonomy and systematics of tsetse flies from the Congo region belonging to the *Glossina palpalis* group—that is, to the sub-genus *Nemorhina*—which are of considerable importance from the medical point of view, since they carry human trypanosomiasis, have been the subject of an intensive study by A. de Barros Machado in a work entitled "Révision systématique des Glossines du groupe *palpalis* (Diptera)" (Pub. Cult. No. 22, Museu do Dundo; pp. 189+107 figs.+8 tables; Lisboa: Companhia de Diamantes de Angola, 1954). Intensive collecting was carried out by the author over Angola and the Belgian Congo. Much of the investigation was carried out in the Museum of Dundo; but this was supplemented by work in the British Museum, the London School of Hygiene and Tropical Medicine, the Museum of the Belgian Congo and the University of Porto. Thus practically the whole of the relevant material, including type material, was critically examined and compared. The specimens are carefully described morphologically, particular attention being paid to the copulatory organs and the range of each species and sub-species considered and illustrated. There are no plates; but the excellence of the paper and reproduction of the many photomicrographs renders them unnecessary. The geographical distribution of each form is carefully determined. The one distribution that appears remarkable is that of *Glossina tachinoides*, which has its main centre between long. 10° W. and 20° E. (there is a slip in the text on p. 151 which on line 7 gives longitude 10° E. instead of 10° W.) and a small subsidiary centre in the Sudan near longitude 34° E. As the author points out, another record of this species from the south-west of Arabia cannot be regarded as satisfactorily established. In passing, it is interesting to note that the form along the border of Tanganyika is *Glossina fuscipes martinii*, while that along the Uganda border is *G. fuscipes fuscipes*. The author recognizes and treats fully *Glossina fuscipes*, *G. palpalis* and *G. pallicera*, all of which are polytypic, and *G. tachinoides*. What is known of the ecology and inter-subspecific fertility of the various forms is adequately set forth and discussed. The paper is extremely well printed and will undoubtedly form a classical work of reference for future work.

Coconut Milk Growth Factors and Tumorous Growth

IN further investigations of the growth and metabolism of plant cells, F. C. Steward, S. M. Caplin and E. M. Shantz (*Ann. Bot.*, N.S., **19**, 29; 1955) have considered the phenomenon of tumorous growth in its relation to growth factors of the kind found in coconut milk, that is, the liquid endosperm of *Cocos nucifera*. This new investigation stems from the observation that coconut milk can induce rapid proliferation in cultures of certain mature tissues (carrot root explants consisting of secondary phloem), that is, in cells which would not normally have undergone further division—a result, in short, reminiscent of the growth of plant tumours. These investigators have now shown that aqueous extracts of plant tumours, induced by *Agrobacterium tumefaciens* on *Bryophyllum* and *Kalanchöe*, can be used as a substitute for coconut milk in the tissue-culture procedures used in their laboratory. On the basis of extensive experiments they have shown that tumours of this kind yield extracts possessing a growth-promoting effect similar to that of coconut milk. This effect may be enhanced by, though it is distinguishable from the effect of, added casein hydrolysate in the basic medium. Tumour extracts were consistently more active than extracts of stems and leaves of the same plants, and of normal, non-tumorous plants. The effect of coconut milk, which is replaceable wholly or in part by tumour extracts, is primarily an effect on cell division in the carrot tissue.

Zygotropism in *Mucor*

IN further physiological studies of the Mucorales, G. H. Banbury has investigated the zygotropism of the zygophores of *Mucor mucedo* (*J. Exp. Bot.*, **6**, 17, 235; 1955). In addition to positive zygotropism between (+) and (−) zygophores, there is claimed to be a corresponding 'repulsion' between zygophores of the same mating type, (+) from (+) and (−) from (−). The stimulus appears to be transmitted by the diffusion of a volatile substance from one zygophore to another. A tentative explanation of the phenomena described is advanced, based on two postulated volatile hormones, each evolved by zygophores of one mating type only, stimulating growth in zygophores of its own mating type and retarding it in those of the opposite type. The results of these new investigations appear to dispose of the 'mitogenic ray' and 'accidental contact' theories of earlier workers.

Visual Education

IN co-operation with Unesco, the Central Council for Health Education has produced the latest issue of its *Health Education Journal* as a symposium on visual education (**13**, No. 1). The contributors are drawn from many parts of the world and, besides members of the Council's own staff, include such distinguished people as "Fougasse" on propaganda posters and Walt Disney on the development of animated cartoons. The use of moving films in combating human and animal disease in Tanganyika

is described by N. F. Spurr, while not the least valuable article is one by Dr. A. L. Knutson, of the United States Public Health Service, who suggests ways in which the effectiveness of visual material may be evaluated.

Ultrasonic Testing of Concrete

The Road Research Laboratory deals with the non-destructive testing of concrete in its Technical Paper No. 34, entitled "Testing Concrete by an Ultrasonic Pulse Technique", by Dr. R. Jones and E. N. Gatfield (pp. 48+2 plates. London: H.M.S.O., 1955; 2*s*. 6*d*. net). Until recently, the only way in which the physical characteristics of concrete and the changes brought about by ageing and other causes could be determined was by tests to destruction carried out on specially prepared specimens. These tests, though useful, are not entirely satisfactory, and a method of measuring changes in the quality of concrete *in situ* by transmitting an ultrasonic pulse through concrete has been extensively investigated and developed at the Laboratory. The ultrasonic equipment described consists of two piezoelectric transducers placed on opposite faces of the concrete under test, and the pulses are timed electrically as they pass from one transducer to the other through the concrete. The time of transmission indicates the characteristics of the concrete and the presence of internal cracks. Any deterioration due to weakness or poor compaction can be detected. Examples are given of the practical applications of the method. The ultrasonic technique can also be used for testing road surfaces; this involves the use of reflexion, the sound pulses being reflected back by the lower surface of the concrete. The difficulty here, however, is that the method is only satisfactory when the underside of the concrete is relatively smooth. In practice, transducers having natural frequencies of 50–200 kc./s. are used because of the upper limit to the frequency imposed by the attenuation of the concrete. The repetition frequency of the pulses is 50/sec., and the accuracy of measurement of the time of propagation of a pulse of longitudinal vibrations between the two transducers is of the order of $\frac{1}{2}$ per cent for concrete. Full details of the apparatus used and of the experimental technique are given in an appendix. Brief reference is made also to applications of the technique to materials other than concrete, for example, soil-cement, rocks, ceramics and wood.

Catalogues of the Exhibits on Heat at the Science Museum, London

Two well-produced illustrated handbooks have been compiled by J. A. Chaldecott, of the Science Museum, London, giving detailed descriptions of the exhibits in the collection of heat and thermal instruments at the Museum. The exhibits are arranged in a number of groups, each dealing with one aspect of the subject, and these groups are further divided into sub-groups within which the exhibits are arranged so far as possible in chronological order. The first handbook, "Heat and Cold" (pp. 64+6 plates. London: H.M.S.O., 1954; 3*s*. net), covers thermal expansion, calorimetry, change of state and critical state, heat and heat transfer, refrigeration and low temperatures, and altogether 166 individual exhibits are listed. In addition, details are given of nine portraits of distinguished workers in the field of heat. The other handbook, "Temperature Measurement and Control" (pp. 65+4 plates. 1955; 3*s*. 6*d*. net), is limited in content to the various types of thermometers, pyrometers, thermostats and temperature recorders, and 153 exhibits are listed. A reference list of thermometers and temperature-recording instruments kept in the meteorology collection of the Museum is appended for completion. In accordance with the 1948 recommendations of the Ninth General Conference on Weights and Measures, 'Celsius' is used for the temperature scale previously known as 'Centigrade'. In both handbooks the catalogue entries consist of the substance of the descriptive labels attached to the various exhibits in the Museum. The details given are most informative, and should be of considerable value and interest to physicists and to those concerned with the history of science. Though modern apparatus is by no means excluded, the emphasis is naturally on the original and earliest forms of thermal instruments. The descriptions of these in most of the text-books is now often so inadequate or incorrect that authors and students would be well advised to use the handbooks, together with a visit to the Museum, for details of particular instruments. For the more serious student, the handbook also provides the reference to the article in which the apparatus or method was originally described or to the maker or designer of a particular item. Photographs of the exhibits and lantern slides may be purchased, and the latter can also be borrowed.

Energy Expenditure in Man: Symposium in London

The Nutrition Society is arranging a symposium on "Energy Expenditure in Man", under the chairmanship of Prof. R. C. Garry, to be held at the National Institute for Medical Research, London, N.W.7, on October 15. Papers will be read on the following topics: the development of experimental methods for determining the energy expenditure of man (Prof. C. G. Douglas, Oxford); modern techniques for measuring energy expenditure (Mr. H. S. Wolff, London); the value of energy expenditure measurements in nutritional studies (Dr. O. G. Edholm, London); daily energy expenditure by man (Dr. R. Passmore, Edinburgh); energy expenditure and age (Dr. J. V. G. A. Durnin, Glasgow); energy expenditure in athletic activities (Mr. H. R. Noltie, Leeds). Further information can be obtained from the honorary programmes secretary of the Society, Dr. R. J. L. Allen, c/o Beecham Foods, Ltd., Brentford, Middlesex.

The Story of Pharmacy: Exhibition in London

An exhibition on "The Story of Pharmacy" has been set up by the Wellcome Historical Medical Museum at the Wellcome Building, Euston Road, London, N.W.1, to coincide with the Sixteenth General Assembly of the International Pharmaceutical Federation, which is meeting in London during September 19–23. The exhibition will be opened by the president of the Federation, Sir Hugh Linstead, on September 19, following the presidential address with which he will open the Assembly. All the objects to be shown at the exhibition have been selected from the collections at the Wellcome Museum and cover the history of pharmacy and related subjects from the earliest times to the advent of antibiotics. The exhibition is sub-divided into the following periods: prehistory, Assyria, Babylonia and Ancient Egypt; Græco-Roman period; the medieval world; the sixteenth century; the seventeenth century; the eighteenth century; and the nineteenth

and twentieth centuries. Many of the objects, books and manuscripts to be displayed are noteworthy not only for their historical and scientific value but also for their beauty as works of art. The exhibition will remain open to the public (admission free) for several months.

Swiss Society for Natural Sciences: Annual Meeting

THE 135th annual meeting of the Swiss Society for Natural Sciences will be held in Porrentruy, Pruntrut, during September 24–26. The general proceedings will open with an address by the president, Dr. E. Guéniat, director of the Normal Teaching College of Porrentruy, on the scientific work of Jules Thurmann (1804–55). Prof. R. L. Gautheret (Sorbonne, Paris) will speak on physiology and nutrition in tissue-culture. Other topics will be: Swiss researches in Central Africa (a programme of scientific films); finalism and physicism (a symposium under the chairmanship of Prof. F. Gonseth, of Zurich); calculating machines in the service of technique and science (Prof. E. Stiefel, of Zurich); and tracking down carriers of hereditary diseases (Prof. A. Franceschetti, of Geneva).

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: G. D. Badger (senior agricultural officer, Uganda), senior agricultural officer (superscale), Uganda; G. S. Cowley (senior agricultural officer, Kenya), assistant director of agriculture (field services), Kenya; G. S. Gollop (senior agricultural officer, Kenya), provincial agricultural officer, Kenya; P. L. Hotchin (agricultural officer, Mauritius), senior agricultural officer, Mauritius; A. E. Moss (assistant director of agriculture, Gold Coast), deputy director of agriculture, Gold Coast; E. J. Honore (conservator of forests, Kenya), deputy chief conservator of forests, Kenya; P. C. Lancaster (principal research officer, Federation of Nigeria), director of forestry research, Federation of Nigeria; D. G. B. Leakey (assistant conservator of forests, Kenya), conservator of forests, Kenya; K. R. M. MacDonald (conservator of forests, Northern Region, Nigeria), chief conservator of forests, Northern Region, Nigeria; R. M. Palmer (senior assistant conservator of forests, Sierra Leone), conservator of forests, Sierra Leone; R. V. H. Porter (assistant conservator of forests, Kenya), conservator of forests, Kenya; T. I. Rees (senior assistant conservator of forests, Western Region, Nigeria), conservator of forests, Western Region, Nigeria; R. Smeathers (deputy conservator of forests, Trinidad), conservator of forests, British Guiana; J. A. R. Bates, specialist officer chemist (agricultural), Federation of Nigeria; B. L. Batwell, agricultural officer, Northern Rhodesia; J. R. Simpson, chemist, Agricultural Department, Uganda; J. Walker, agronomist, Somaliland Protectorate; J. Jago, government chemist, Zanzibar; J. P. de C. Walsh, assistant conservator of forests, Northern Rhodesia; J. V. Huhta, mining geologist, Sierra Leone; D. J. Slater, geologist, Federation of Malaya; A. J. Warden, geologist, Somaliland Protectorate; R. Q. Craufurd, scientific officer, plant breeder, Sierra Leone; J. Thorsen, veterinary officer, Northern Region, Nigeria.

Announcements

MR. H. A. SARGEAUNT, at present scientific adviser to the Army Council, has been appointed assistant to Dr. H. P. Robertson, of the United States, scientific adviser to General Gruenther, the Supreme Allied Commander, Europe. Mr. Sargeaunt will be succeeded as scientific adviser to the Army Council by Mr. Patrick Johnson, formerly director of studies at the R.A.F. College, Cranwell, and since 1952 dean of the Institute of Armament Studies, India.

PROF. J. HEYROVSKÝ, academician of the Chemical Sciences Section of the Czechoslovak Academy of Science, Prague, has been elected president of the Polarographic Society in Great Britain (see *Nature* of January 1, p. 20). He hopes to deliver an inaugural address in the near future.

EDWARD LONGSTRETH MEDALS of the Franklin Institute, Philadelphia, have been awarded to C. Waller, of Ilford, Ltd., and Dr. R. Berriman, of Kodak, Ltd., for their work on the development of photographic emulsions especially designed for the study of nuclear particles and events.

MR. E. LL. HARRY, provincial director of the West Midland Province, National Agricultural Advisory Service, has been appointed director in Wales in succession to the late Mr. D. Walters Davies. Dr. D. H. Robinson, deputy provincial director for the West Midland Province, will succeed Mr. Harry in that area.

THE British Oxygen Co., Ltd., has awarded the following three fellowships for postgraduate research: R. Clarkson (formerly of the University of Manchester), chemistry, at the University of Oxford; R. A. H. Pool, inorganic chemistry, at the University of Oxford; and D. I. Wilkinson, organic chemistry, at The Queen's University, Belfast.

THE following appointments in the University of London have been announced: Mr. H. L. Elvin, director of the Department of Education of Unesco, to the University chair of education with special reference to education in tropical areas, tenable at the Institute of Education; Dr. A. H. M. Arnold, head of the Electronics Section of the Electricity Division of the National Physical Laboratory, to the University readership in electrical engineering tenable at King's College.

THE Trustees of the Ciba Foundation for the Promotion of International Co-operation in Medical and Chemical Research are offering five awards, of an average value of £300 each, for the period 1955–56, for research relevant to basic problems of ageing. Entries will be judged by an international panel, and in making the awards preference will be given to younger workers. The work submitted should not have been published before July 31, 1955. Further particulars can be obtained from the Director and Secretary to the Executive Council of the Ciba Foundation, 41 Portland Place, London, W.1, to whom entries must be sent by February 10, 1956.

THE Swiss Federal Institute of Technology, Zurich, will hold its centenary celebrations during October 17–23. A programme of lectures and excursions, primarily intended for the old students' association, will be held during October 17–20.

ERRATUM. In the leading article in *Nature* of August 27, p. 365, par. 1, it is stated that "earlier hopes that alginates would serve as a technically and economically desirable source of chemicals have been disappointed"; this should read "earlier hopes that seaweeds would serve as a . . . source of chemicals other than alginates. . . ."

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, AUSTRALIA

REPORT FOR THE YEAR 1953–54

THE sixth annual report of the Commonwealth Scientific and Industrial Research Organization, Australia, covering the year ended June 30, 1954*, again stresses the difficulties in attracting first-class men to research careers in science. The position became markedly worse during the year and is regarded as alarming. At the beginning of the year there were vacancies for 112 research officers, for which the minimum requirement is a good honours degree, and at the end of the year there were still 109 such vacancies. Recruitment of technical officers, however, was satisfactory; but concerted efforts to recruit scientific officers from overseas, mainly the United Kingdom, had most disappointing results, and the Executive believes that it is a matter of great urgency that the prospects for specialists and highly qualified professional scientific workers in Australia, both in public and private employment, should be greatly improved. Expenditure for the year was £4,861,873, of which £3,615,121 was on normal research activities and £98,271 as grants to bodies such as the Commonwealth Agricultural Bureaux. £569,038 was expended from the Wool Research Trust Account (for which £390,807 was received from the Department of Commerce and Agriculture), £372,399 from the Wool Industry Fund and £205,081 on sundry projects for which grants were received from outside bodies.

In the Division of Soils, the group concerned with soil mineralogy is developing into a new section, and a small new unit for field-work has been set up at the Irrigation Research Station, Griffith, N.S.W. A new soils laboratory has been established at Canberra, and a Soil Survey Co-ordination Committee in Victoria, while a further such Committee is being organized in Western Australia, where the soil survey of the Swan valley is complete. In the low-fertility lands of the Tintinara district of upper south-east South Australia a soil map and report on three hundred square miles have been completed and also field-work on four hundred and fifty square miles of similar lands in the Tatiara district. In soil chemistry an investigation into the ion-exchange relations of various cation-dominant soils has been completed, and in further experimental work on the availability of manganese and other heavy elements an improved method has been devised for the extraction of divalent manganese from soils, based on the use of salts of ethylenediamine tetraacetic acid. Typical Western Australian lateritic profiles have been examined spectrographically, and possible correlations in the concentrations of copper, gallium, magnesium, manganese, molybdenum and vanadium in samples of Urrbrae loam are being examined. A simple method has been devised for extracting the exchangeable cations in calcareous soils, and studies of the interactions of sodium, potassium, calcium and magnesium indicate that calcium has a marked effect on the determination of magnesium in a flame spectrophotometer. Further work is being carried out on the effect of initial water content on the water stability of soil aggregates, and studies have been made of the virulence and incursion strains of *Rhizobium trifolii*, while attempts are being made to isolate proteins and saccharides from soil humus by electrophoresis.

The Division of Plant Industry has considerably expanded the work in agrostology and agronomy in Queensland, and good progress is reported in work which is to open up the coastal lowlands of south-eastern Queensland for intensive pasture development. At Canberra evidence was obtained that clovers may compete with grasses for the nitrogen which they themselves assimilate, and that grass development may suffer from competition for nitrogen by the associated clover. For full efficiency of assimilation of nitrogen by legumes, it seems necessary to utilize the nitrogen they incorporate in the soil, either as hay removed from the area or by cropping. In genetics a programme of inter-specific hybridization in the Australian grasses is planned, while inoculation experiments with *Phytophthora infestans* on *Acacia*, *Cassia* and *Erythrina* spp. showed that the parasite penetrates the leaf epidermis but is checked by a severe 'defence' reaction which is similar to the lesion reaction known in cereals infested with rusts and some other parasites. Systemic absorption of streptomycin by potato and tomato plants led to a change in the reaction of the host to infection by *Phytophthora infestans*, the causal organism of late blight.

Most of the work at Hobart on the physiology of apples in relation to storage disorders is concerned with the effect of manurial treatment on cell size and physiology in relation to keeping quality. Extensive agronomic and breeding studies on safflower (*Carthamus tinctorius* L.) were continued, and also breeding for resistance to tobacco mosaic. Resistance in the variety Ambalena is associated with slow multiplication and spread of the virus followed by inactivation within the plant. A method has been developed for the determination of molybdenum in soils, and considerable progress was made in the study of the effects of lime on the nodulation of clover. Factors affecting the response to fertilizers were being examined, and a study of the effects of deficiencies of essential elements on the amino-acid composition of plants was continued. Contrary to the established view, glutamine has proved superior to asparagine as a source of nitrogen for the growth of isolated embryos of *Medicago tribuloides*, and quantitative relations between glutamine and asparagine were being established for a range of leguminous and non-leguminous embryos. Surveys to classify and map plant communities were proceeding in the Southern Tablelands, Macquarie and New England regions of New South Wales, and in the rain-forest regions of Queensland and northern New South Wales. An investigation was initiated on the biochemistry of morphogenesis in plants, particularly the induction mechanisms underlying the formation of a new meristem during regeneration and its subsequent mode of differentiation. Studies on root concen-

* Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization. Sixth Annual Report for the Year ending 30th June, 1954 (1953–54). Pp. vi+372. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1954.)

tration and chloride content in native pastures at Deniliquim, New South Wales, indicated that the growth of grasses in the *Atriplex vesicaria* community was limited by 0·23–0·43 per cent of sodium chloride in the 3–9 in. depth. A pot trial using grey clay soil and sandy loam soil from areas which had been under native pasture, and from other areas which had been under fertilized irrigated pasture for six years, showed that 'Krilium', while greatly improving the aggregate stability of both loam and clay soils and reducing the mass shrinkage of the latter, depressed yields on clay soils and increased them slightly on loam soils, the effect being most marked on soils which had not been irrigated. The ecological survey of the coastal lowlands of south-eastern Queensland continued, and work was commenced on the genetical aspects of selected pasture legumes and grasses relevant to their improvement and adaptation to coastal and sub-coastal Queensland.

An important part of the work of the Irrigation Research Station at Merbein, Victoria, deals with the reclamation of deteriorated horticultural lands which have not responded to tile drainage. Of the horticultural crops, vines for dried fruit are the most important, and investigation of some of the components of sultana-yield continued and also of manurial and cultural practices. Flowering and fruiting in citrus have been further investigated and the programme of tomato breeding for field and glasshouse continued. The work of the Irrigation Research Station at Griffith, N.S.W., has been designed to lay the basis for an effective counter to water-logging and salting and to develop more efficient techniques in the use of irrigation water.

The Animal Genetics Section of the Division of Animal Health and Production, which was established in 1952 with the co-operation of the University of Sydney, besides investigating the application of genetics to animal breeding, endeavours to introduce university students interested in genetics to the techniques and concepts of quantitative inheritance. It has been found that, whereas heritability of response to a simple antibody is high, heritability of response to a complex one is low. Following the demonstration by the Division of Biochemistry and General Nutrition that areas in South Australia abandoned as useless for agriculture can be transformed for efficient production when trace deficiencies of zinc and copper have been rectified, complementary work on pasture improvement has shown that vast areas of Australia, particularly in regions of low rainfall, can also be rendered more productive after trace-element adjustments have been made. An investigation on chronic fluorosis in sheep, now virtually complete, has proved that waters containing 10 p.p.m. fluorine are harmful to grazing stock and that the untoward effects of chrome fluorosis on the general well-being of the sheep arise primarily from the teeth lesions. A main activity of the Division's work on sheep during the year has related to the effects of molybdenum on the copper metabolism of the sheep and to the effects of imposing considerable doses of sulphate, etc., on relatively high intakes of molybdenum. Administration of a supplement equivalent to 1 mgm. cobalt/day as a drench once a week completely protected sheep from '*Phalaris* stagger', a fatal malady occurring spasmodically among sheep grazing essentially on the perennial grass *Phalaris tuberosa*. Research on the biological activity of complex ions was continued by the Division in collaboration with the University of Sydney. Further therapeutic trials were carried out with antibiotics against staphylococcal mastitis in dairy cattle and studies were being made to determine the factors responsible for outbreaks of hæmonchosis. In an investigation to discover a chemical method of assessing the resistance of strains of ticks to acaricides, it was found that when DDT is dissolved in normal primary alcohols, butyl, amyl and hexyl alcohols gave the greatest penetration.

The work of the Division of Entomology continued to be increasingly concerned with the more fundamental aspects of entomology. In current research on the cattle tick, the emphasis has shifted to the strategic timing of dipping, so as to ensure that from time to time all the ticks in a given area are exposed to dipping, and not merely those which happen to infest the animals at a given moment, and to the 'spelling' of pastures, with a similar object. In Western Australia more attention was being given to ecological studies on the earth mite and lucerne flea than to chemical treatment, and promising results were obtained in the campaign in Sydney for eradicating the Argentine ant. A study was commenced of the ecology and pathology of the black beetle. Using the sheep blowfly (*Lucilia cuprina*) as experimental animal, work was continued on the way populations accommodate themselves to external stresses. The study of the effects of airtight storage conditions on the grain weevil, *Calandria granaria* L., has shown that all stages are killed by the reduction in oxygen due to the respiration of the insects and the grain.

The work of the Wildlife Survey Section on myxomatosis has included regional surveys to assess the seasonal performance of the disease and to collect information on local variations, intensive investigations into the ecology and behaviour of insect vectors, and work on variant strains of the virus. A field-station for the intensive investigation of the kangaroo and euro problem has been established in north-western Australia. The Australian Mainland Survey Unit of the Land Research and Regional Survey Unit concentrated its effort in the Leichhardt-Gilbert area. The Section has also made a survey of Nauru Island and conducted some agricultural research in North Australia, including problems of dryland agriculture and a programme of testing plant introductions.

The work of the Division of Fisheries was again limited to coastal waters, because only two small research vessels were available. A detailed histological study of the reproductive cycle of the western subspecies of the Australian salmon continued, and a study of the relative abundance of estuarine species in Lake Macquarie, New South Wales, and their interaction was commenced in conjunction with environmental studies on the hydrology, microbiology and planktology of the Lake. An extensive survey in February 1954 of the south-western Tasman Sea demonstrated the path of the east Australian current in this area and the continuity between southern Tasmanian waters and the deep Tasman Sea waters below the 12° C. isotherm.

Despite progress in the investigations on beef, methods for the elimination of 'drip' from frozen and thawed beef are unlikely to be found in the near future. The precise water requirements of a number

of strains of bacteria causing spoilage or food poisoning have been defined, and the amounts of water in various foods which will permit the growth of these organisms can now be predicted. A dip of sodium *o*-phenylphenoxide has proved the most effective method of reducing the green mould which is the chief cause of wastage in oranges grown in the natural rainfall districts. Using the maturometer and experimental techniques developed by the Division of Food Preservation and Transport, it has been found that the general developmental pattern of varieties of peas tested at Geneva, New York, agrees with that determined in Australia. Respiration studies have led to a hypothesis connecting the energy liberated by respiration with the energy-requiring processes in the cell, and this hypothesis has been used to interpret the sudden rise in respiration associated with the ripening of fruits. Attempts are being made to find improved methods of storage for apples.

The Division of Forest Products continued the study of the anatomy of tubers occurring in the south-west Pacific area and completed a detailed study of the influence of chip shape on the delignification of *E. regnans* wood by sodium sulphide and by sodium hydroxide. Studies were commenced on the rheological properties of hand sheets made from typical pulps of different qualities. A pressure membrane apparatus has been designed to study sorption of water by wood at relative humidities above 98 per cent; a quantitative comparison of creep at constant stress with stress relaxation at constant deformation showed that wood behaves approximately as a linear viscoelastic body, but attempts to establish an empirical formula for the relation between impact strength and moisture content were unsuccessful. Studies were commenced on the influence of physical conditions on vapour movement in hardwoods.

The work of the Division of Building Research continued on similar lines to that of the previous year. Information obtained from the study of the mechanism of the failure of concrete under load has led to a tentative theory of rupture of concrete in which the criterion of failure is a function of the shear-strain energy per unit volume and the volumetric expansion. Thermal and X-ray examination of synthetic gypsum indicated that the conditions of precipitation influence the behaviour during dehydration. In the Wool Textile Research Laboratory at Melbourne, work on the fundamental properties of the proteins of the wool fibre has been intensified, with particular emphasis on methods for separating and analysing the protein entities present. Further research in weaving and dyeing was commenced at the Geelong laboratory, while work on the physical properties of the wool fibre and assemblies of wool fibres continued at the Sydney laboratory. The Plant Fibres Section completed mill-scale trials on the so-called aerated retting of flax, and a comprehensive investigation of the effect of atmospheric temperature and humidity on the performance of various fibres during spinning; it also continued basic studies on flax-retting bacteria as well as its study of the treatment of flax and other fibres with sodium hydroxide.

The Division of Industrial Chemistry commenced a programme of basic research into the properties of uranium di- and tri-chlorides. Satisfactory methods have been evolved for the production of commercially pure thorium nitrate, and studies on the electroreduction of hexavalent chromium solutions have shown that the hydrogen chromate ion is much more easily reduced than the normal chromate ion and plays an important part as an intermediate product. A detailed study of the phototropic darkening of synthetic titanium dioxides when contaminated with iron oxide has shown that chromium, nickel and copper also produce a phototropic effect and that, although some of the rutile modification of titanium oxide (and also moisture) must be present, the most intense coloration, with iron, develops for the smallest conversion of a pure anatase modification to the rutile form. Investigations of the factors which, by causing mechanical stresses, decrease the life of the linings of rotary cement kilns continued, and an extensive series of measurements of the rates of organic reactions at pressures up to 15,000 atmospheres has shown that those reactions which produce ions from neutral molecules are assisted by pressure, whereas the converse reactions are suppressed. A new extraction process using solvents has been devised and demonstrated on the separation of alkaloids, and very promising results have been obtained in small-scale out-of-doors tests of the use of thin films of long-chain alcohols to retard the evaporation of water.

Work has also continued on the structure of crystalline and non-crystalline proteins, on the chemical physics of the solid state, the determination of molecular structure by X-ray diffraction and electron diffraction methods, and on the improvement of experimental techniques and development of new instruments, including a mass spectrometer, an electron microdiffraction camera, a microtome and an atomic absorption spectrophotometer. In organic chemistry, work continued on the pyrrolizidine bases responsible for liver damage in stock, and structural studies of the three minor bases of *Heliotropium europaeum* and an investigation of *Lupinus pilosus* were completed. Further work was done on increasing the unsaturation of olefinic substances with the view of converting low-grade non-drying oils into more valuable materials with drying properties, and the study of the phenol-formaldehyde with *o*-6-xylenol and excess alkali showed that the reaction is complex with regard to the concentration of xylenol, formaldehyde and hydroxyl ion. In chemical engineering most of the resources have been directed to the study of the techniques and reactions in the gasification of low-rank coals.

Further work was done on the magnetic separation of chromite from ilmenite, and a study was being made of the ignition and combustion characteristics of Australian coals with particular reference to their evaluation for combustion; the mechanism and rate of formation of methane in pressure gasification were being studied to provide a better understanding of the Lurgi gasification process, and the effect of pressures up to fifty atmospheres on the rate of the primary steam-carbon reaction was also being investigated. In physical metallurgy the titanium project has been extended to include the deformation and mechanical properties of titanium and its alloys at both normal and high temperatures, and the study of the creep of lead and its alloys continued. The Division of Tribophysics continued its work on the same general lines as in the previous year, including studies of the adsorption of long-chain organic compounds on solids

of various types, of the mechanical properties and composition of films of long-chain compounds, and of solutions containing metallic ions. Measurements of energy stored in deformed nickel were continued, and studies of the effects of antioxidants on the decomposition of benzoyl peroxide indicated that free radicals are not involved.

The maintenance of Commonwealth standards of measurement is shared by the Divisions of Metrology, Physics and Electrotechnology, which comprise the National Standards Laboratory. The work on standards of length and their international comparison continued, and another important piece of work by the Division of Metrology was a very accurate determination of changes in density of strained material on annealing. The principles and practice of vibration and shock isolation were also investigated; to increase the precision of maintenance of the International Temperature Scale, the Division of Physics constructed new apparatus for the primary fixed points defined by the boiling points of water and sulphur and was constructing a precision manometer for measuring the controlled pressures at which boiling occurs. A new method has been devised for the measurement and control of humidity, using a small ionic crystal as detector. Particular attention was given to the thermal and electrical conductivities of solids at very low temperatures. In the Division of Electrotechnology the special resistor for building up from one to a hundred ohms was completed and tested, and work continued on the relation between the chemical and physical structure of organic and some complex inorganic compounds and their dielectric properties. Besides dielectric measurements on a wide range of urea occlusion compounds, a portable bridge was made for measuring the temperature and salinity of estuarine waters to a depth of sixty feet.

The Division of Radiophysics continued its fundamental work in rain and cloud physics and in radioastronomy, and has also investigated a proposed method of navigating long-range aircraft by measuring the distance from the terminal points of the path. Ionosphere measurements were concentrated on studies of the anomalous *F*2 region, the conductivity of the ionosphere, and storm morphology and ionization movements in the ionosphere. In atmospheric physics the work included the study of the dry-monsoonal circulation which predominates over the west and north-west of Australia; an intensive investigation of the transfer of heat and water vapour from the ground surface to the atmosphere, of the frictional influence of the ground on the wind and of the prevention of frost in citrus; and a scientific study of the natural processes which give rise to cloud and rain and of possible methods of stimulating rainfall by artificial means, in which powerful microwave radar techniques have been of great assistance. Observations of radio-frequency radiation from cosmic sources and from the sun were continued, and a method was devised of obtaining an effective pencil-beam aerial of high aperture and angular discrimination at relatively low cost. Work on the analysis of rainfall records was concluded, and although the electronic computer could not be completed in accordance with the original design specification, it has been operated with reasonable efficiency on a wide range of problems.

SCIENTIFIC RESEARCH AND MAN-POWER IN THE UNITED STATES

IN addressing the sixth annual conference on industrial research at Columbia University, New York, Dr. A. T. Waterman, director of the National Science Foundation, outlined the survey of scientific research and development in the United States which is being conducted by the National Science Foundation. For the fiscal year beginning July 1, 1955, the United States expenditure on research and development is expected to exceed 4,500 million dollars, 2,400 million of which will be borne by the Federal Government.

Dr. Waterman anticipates that a fourth volume of the Foundation's continuing study, "Federal Funds for Science", covering the years 1954–56, would be published shortly. He notes that 98 per cent of the total funds are accounted for by seven of the twenty departments or agencies of the Federal Government which reported funds for scientific research and development, and that, of these twenty, only the National Science Foundation and the Smithsonian Institution have used all their research funds for basic investigations. The Foundation has also undertaken a historical summary of Federal funds for science during 1900–54 and an analysis of the Federal financing of higher education. One of the agricultural experiment stations was expected to be complete late this year. A history of the activities of the Federal Government in science during 1789–1940, by Dr. H. Dupree, was reported as being almost complete, and the most significant data on scientific man-power in the Federal Government are being compiled in a separate monograph. A study of the financial support of graduate students (which covered 152,000 of the 225,000 graduate students of 1954) is nearing completion. Twenty-five per cent of the students covered held teaching or research assistantships or fellowships in April 1954, and 20 per cent were enrolled in the natural sciences.

A preliminary report on foundation expenditures for scientific research, covering seventy-seven foundations with assets totalling 3,000 million dollars and an income of 166 million dollars, of which about 16 per cent went for scientific research and development, indicates that only forty-three of the foundations gave support to scientific research at all and that this support is decreasing in comparison with other fields of study, while there is a trend from the support of basic research towards applied research and development. Industry conducts about 65 per cent of the national industrial research effort and finances 42 per cent of this total; but the industrial survey is not yet complete, and although a preliminary survey has been made of research being conducted by trade associations, studies of the economic implications of research are still in the planning stage. A preliminary draft has been received of a report on shortages of scientific and engineering personnel in industrial research, and studies are being sponsored of three problems: the loss of talent through educational 'drop-out'; estimating the supply of technical and professional man-power for 1965; and methods for determining demand and supply of technical personnel. It is hoped to present the findings of these studies in a series of general reports.

PLASTICITY OF MATERIALS

SYMPOSIUM IN LONDON

A TWO-DAY symposium on plasticity, arranged by the Armament Research and Development Establishment (Ministry of Supply), Fort Halstead, with the co-operation of representatives from universities, establishments of the Department of Scientific and Industrial Research, and industry, was held in London at the Assembly Hall of the Royal Empire Society during July 4–5. The director of the Armament Research and Development Establishment, Mr. Ewen M'Ewen, opened the symposium with an address of welcome to about eighty delegates, in which he reminded his audience that the subject of plasticity was forged in the genius of Saint-Venant; he stressed the continuing progress in the subject, particularly within recent years.

In four sessions of the symposium, eleven papers were presented and discussed. The papers taken as a whole represented a fair cross-section of the general nature of the work on plasticity proceeding in various centres not only in Great Britain but also elsewhere. Thus typical problems with a bias towards either engineering, physics or mathematics were described. The wealth of variety in the problems currently receiving attention was apparent, and this situation should increasingly attract research workers to this field. An adequate summary of the papers would perforce either be very lengthy or assume that the reader had a detailed knowledge over a wide horizon in the general field of plasticity. As most of the material presented is either already available or will become available in due course, an account will be given in this article only of the discussion that followed the papers.

After Prof. D. G. Christopherson had introduced the discussion, Prof. H. Ford directed attention to the practical importance of the Bauschinger effect and to the development of anisotropy in continued plastic deformation as, for example, in cold rolling; he made a plea for the theoretical study of the effects of departure from the assumptions of isotropic plasticity. Dr. J. F. W. Bishop replied that Prof. R. Hill had formulated a theory of anisotropic plasticity. The real obstacle to progress lies in the intrinsically difficult nature of the governing equations, and the incorporation of anisotropic effects in the theory does not pose the major problem. Dr. Bishop emphasized the importance of studying the inter-relation of crystalline and macroscopic plastic properties of metals in order to develop further the physical basis for the mathematical theory of plasticity. Otherwise, this theory will necessarily involve at least some features at a phenomenological level.

Dr. J. W. Maccoll said that he has observed a recent trend towards a preference for the Tresca yield criterion, as opposed to that of von Mises, for a material under combined stress, in the theoretical treatment of problems. This is due largely to reasons of mathematical simplicity. He was glad to note the remarks of Dr. Bishop justifying, on the basis of the physics of single metal crystals, the occurrence of singular points on the yield surface. Singular points are, of course, an essential feature of the Tresca yield criterion. Dr. Maccoll thought that more attention to the physical basis of the mathematical theory of plasticity, previously emphasized by Dr. Bishop, might not only point the way to, but would also justify, simpler mathematical approaches in macroscopic plasticity. Prof. Christopherson then raised the general question of the computation of bounds to the solution of problems. In reply, Mr. A. P. Green said that the methods available are not of sufficient generality. He also expressed the opinion that the relationship between the mathematician's ideal rigid-plastic material and actual metals requires further careful exploration. In respect of one of Dr. Maccoll's remarks he cautioned against the facile assumption that the analytical solution of a problem is always moderately insensitive to changes in the yield condition and plastic potential, and counter-examples were recalled.

Mr. H. G. Hopkins returned to Prof. Christopherson's question, and said that the fundamental trouble is that a general method of construction of sequences of approximate solutions which converges to the true solution of a problem in plasticity is not available at the present time. In this respect there is a sharp contrast to problems of elasticity, where such methods are available and are much used in technical applications. Prof. Christopherson added that one difficulty is to decide *a priori* the extent of plastic regions. He went on to ask about general theorems in visco-elasticity. Mr. D. R. Bland said that any general theorems involving potential energy would be applicable to dynamic elasticity, and that there are few theorems known in that field. Therefore, it seems that such theorems in visco-elasticity will concern the dissipation function as well as the potential function. Dr. H. Kolsky made a plea for a greater volume of experimental work on visco-elastic solids to provide more adequate data for the theoretical treatment of problems in this field. Prof. Christopherson was impressed by the apparent simplicity of the theoretical models used to simulate the actual mechanical behaviour of visco-elastic solids. Dr. Kolsky replied that the degree of agreement is not always completely satisfactory, and this is why more accurate experimental data are needed. Mr. Bland observed that recent work of his indicates that the theoretical analysis of certain visco-elastic problems can be based directly on the complex modulus versus frequency relation instead of proceeding via the stress–strain relations.

H. G. Hopkins

BRAZILIAN SOCIETY FOR THE PROGRESS OF SCIENCE

ANNUAL MEETING

THE seventh annual meeting of the Brazilian Society for the Progress of Science (Sociedade Brasileira para o Progresso da Ciência) was held during July 4–9 at the Engineering School in Recife, Pernambuco. The president for the meeting was Dr. Anísio Teixeira, director of the National Institute of Pedagogical Studies of the Brazilian Ministry of Education, and the inaugural lecture on "Some Aspects of the Development of Mathematics in Brazil" was delivered by Dr. Leopoldo Nachbin.

The chief guest was Prof. Bernardo Houssay, of Argentina, who delivered a lecture on "General Considerations on Research and its Role in Latin America". Other foreign guests included Dr. L. Leloir, also from Argentina, and the science officer

of the British Council in Brazil, F. M. Beatty, who lectured on British scientific travellers in the north and north-east of Brazil. Some 136 scientists and others attended this year's meeting. The programme included about 160 papers, mainly on biological subjects. Local scientists contributed especially to the sessions on nutrition in the north-east of Brazil and on mycology. In addition, special symposia were held on spot tests, experimental psychology and education, enzyme activity and, of more general interest, on "Science and Humanism". A memorial lecture on Einstein was given by Prof. Mario Schenberg, of the University of São Paulo. The principal functions were attended by Dr. Gilberto Freire, the well-known Brazilian sociologist.

The meeting was pleased to hear the message, read before one of the lectures, bearing fraternal greetings from the British Association for the Advancement of Science. The next meeting is planned to take place in Ouro Preto (Minas Gerais) in July 1956.

PROBLEM OF REWARDING RESPONSIBILITY

IN the past twelve months much has been heard of the skill differential between craftsmen and labourers; for example, engineering tradesmen and labourers; building tradesmen and labourers; and, more recently, footplatemen and other railway workers. Less easy to define, though just as pertinent a problem, is the wage relationship in many manufacturing industries between various categories of unskilled or semi-skilled process workers. There is also the problem of wage relations between workpeople paid by results and those paid by time-rates for whom no opportunity to earn incentive bonus has been provided. There are, of course, many other differentials, such as those based on sex and age, time and place. Differentials are sometimes as potent a source of friction in industrial relations as the question of the wage-level itself; their effects have been elaborated by G. R. Moxon and H. J. Perkin (*Personnel Management*, **37**, No. 332; June 1955).

Before 1914 the rates of pay for unskilled workers were 50–65 per cent of those for apprenticed craftsmen; to-day they are nearer 80 per cent. The pace at which differentials have narrowed has accelerated since the War. The trend is accounted for by the bargaining strength of trade unions, particularly among the less skilled, in conditions of labour shortage and, latterly, very full employment; by the social conscience of what constitutes a fair minimum time-rate of wages; by social insurance and by acceptance of the wider application of the principles and practice of collective bargaining, conciliation and arbitration. The practice of giving the same general wage increase to all grades is the most obvious post-war feature of the drive towards a more egalitarian distribution of the national product.

Yet, difficult as is this problem of differentials, it is doubtful whether it can compete in complexity, obscurity or long-term significance for the well-being of industry, with the problem raised by the narrowing of another group of differentials, those based on responsibility. It is substantially true that the premium paid to those who direct, organize and supervise the work of others has dwindled as fast as the premium paid to skill.

This is not a problem peculiar to industry; it is found wherever responsibility is exercised: in the Civil Service, banks, local government and, probably, most professions, and is part of the general trend towards greater equality between traditionally middle-class and working-class occupations. Indeed, the problem may well be more acute outside industry than it is inside, where the employer can more readily assess and determine fair differentials to be paid for various positions of responsibility.

In their article, Moxon and Perkin explore the social and economic setting in which the problem has come about, and discuss some of the factors which give it its peculiarly intractable shape.

Their discussion is chiefly concerned with middle and junior management—overseers, foremen, departmental managers and technical assistants, whose training demands that they should exercise leadership, organize work, use and keep abreast of modern management, methods and controls, but whose living standards are being overtaken from below.

The problem is obscure because information about salaries is not available except under privilege. The problem is complex because it is by no means confined to the comparative size of the pay-packet. That it also includes questions of status, privilege, job security and pension rights—in all of which there has been a narrowing of the traditionally held differential—is obvious.

The background to the problem is formed by the social revolution of the past half-century. Fifty years ago society was a tall pyramid with many steps. A small group at the top was very rich, and a somewhat larger group very comfortably off: together, this top 1 per cent of income earners received nearly 30 per cent of the nation's income. At the bottom about a third of working-class families lived below the poverty line.

Fifty years of revolutionary reform have changed all that. Graduated taxation has levelled down the incomes, and, to a smaller extent, the capital of the rich. At the same time, social services and the remarkably rapid rise of the lower-paid worker have practically abolished poverty.

This means that the great majority of family incomes fall, after tax, within a narrow range of annual income—say, from £300 to £2,000. There is thus much room for differential awards. While the real earnings of almost all manual workers have risen (though skilled and adult male earnings less than unskilled, women's and juveniles'), salaries in real terms have in most cases been reduced.

At the same time, alongside the growth of the Welfare State, the trend towards greater equality of security and amenity has been reinforced by developments within the factory itself. Shorter hours, the five-day week, paid and longer holidays, canteen facilities, and the growing implementation of pension schemes, are extending to the manual worker a share of the privileges once exclusive to staff.

This measure of equality greatly aggravates the problem of rewarding responsibility. In many cases, middle and junior managers know that at least some of the workers they supervise enjoy a standard of living higher than their own.

The paradox is due to arbitrary differences in family circumstances, operating within a smaller net income range. First, the number of earners in the family, especially since the earnings of women and juveniles have increased, can make a significant

difference. In general, the higher the status, the less likely is it that wife or children will contribute to the family budget.

Secondly, in spite of family allowance, tax reliefs and social services, commitments vary disproportionately from family to family. It is traditional for the salary earner to maintain standards of dress and spending appropriate to his status. His expenditure on other commitments, notably housing and possibly education, will be greater than the wage-earner's.

The problem of differentials in industry is substantially the same problem as that faced by society as a whole: how to share out inadequate resources between the various claimants. More specifically, it is a problem of two competing demands: the demand for fair shares and the demand for incentives for skill, initiative, ingenuity and responsibility.

To such problems there is no perfect solution. Any system of rewards must of necessity be a compromise—a reconciliation of incompatible claims. The compromise should provide a reasonably satisfactory reward for those who, inside and outside industry, carry the responsibility for upholding and extending our standards of life. This problem of rewards for responsibility is less critical and less explosive than that of differentials due to skill. The skill differential compels attention because its holders are organized and can use the force of a pressure group to publicize their grievances and gain their ends. No such relief is open to responsibility-holders.

Nor can they hope for a reversal of the social revolution which has aggravated the narrowing of their differentials. It is most improbable that there will be any return to the inequalities of pre-war days. For the narrowing of differentials there is no remedy but acceptance.

There are a number of factors helping to predispose responsibility holders to accept a reasonable narrowing of differentials. First, the rewards of responsibility are not limited to material benefits, in cash or in kind. There are satisfactions to be gained from the exercise of responsibility itself: from a sense of doing a worth-while job. The Americans, but not the British, have inculcated that feeling into their industrial management at all levels.

Secondly, differences in monetary reward matter less once basic provision is secured for the major needs of life. The hardships experienced by some salary earners are, on the long view, comparative only, and take on an unreal appearance when set beside the poverty the social revolution set out to cure.

Thirdly, many of the responsibility-holders of to-day have risen, often via State-aided education, from lower down the social scale. They are less conscious of a traditional standard of living that they must maintain.

If the narrowing continues, what are the dangers which may result from it? There are two which are of real concern. One is that discontent may develop to the point where recruitment to positions of responsibility falls off and shortages occur; this appears to be the case with science teachers and with dentists. The other is that discontent will sap initiative and result in an immersion in unprogressive routine. Either, if it became widespread in industrial management, might make all the difference between a rising rate of productivity and a falling one.

The great enemy of all differentials is inflation. The pay-packet of the wage earner, especially the less skilled, has on the whole kept ahead of prices. Inflation seems to have become an instrument for re-allocating the national income in favour of those with the biggest bargaining power. Worse than its effect on the immediate purchasing power of salaries is its effect on savings and pension funds.

A stabilization of prices is extremely desirable; but it demands a self-restraint on the part of organized labour on which it would be unrealistic to rely. Many firms are already countering the narrowing responsibility differential by reviewing and re-assessing staff salaries whenever new wage settlements are made. It would be an act of prudence and justice if all followed the lead of the best. Though the problem has not reached the proportions of a crisis, no one can view with equanimity any further narrowing of the differential based on responsibility.

There are no quick solutions to the problem of rewarding responsibility. It is a matter for patient, long-term bargaining and readjustment.

ATMOSPHERIC POLLEN

H. A. HYDE (*Proc. Linn. Soc.*, **165**, 2, 107; 1955) has contributed new observations on the frequency of occurrence of pollen in the atmosphere which seem likely to be of interest to other investigators, including students of floral biology and quaternary botany, plant breeders, and members of the medical profession who are concerned with the problems of pollen allergy. The gravity slide method was used in making this pollen census. In the course of some ten years work, and making use of twelve different collecting stations, it has been possible to determine about 90 per cent of all the grains on the slides and to assign these to one or other of sixty-five different types.

The principal pollen types, listed in the order of their numerical importance, begin with the Gramineae with 48·3 per cent, followed by *Ulmus* with 11·6 per cent, *Quercus* 8·2 per cent, and so on down to *Ranunculus* with 0·41 per cent, and the sedges with 0·22 per cent. Variations in the pollen catch and in the preponderance of the different types from year to year in relation to weather conditions are considered and some interesting conclusions drawn. These are but indications of the several records presented and discussed.

On the subject of hay-fever, the author writes: "No kind of pollen is likely to evoke symptoms in a significant number of people unless it is formed and liberated in large quantities and is buoyant (so becoming and remaining airborne) and unless the source plant is widely and abundantly distributed. The results of the Cardiff pollen census, when considered in the light of this principle, show that the chief hay-fever plants of Great Britain are relatively few in number, viz., the grasses considered as a single group (since all kinds of grass pollen are generally assumed to be similarly antigenic), certain trees, viz., the oaks, ash, the elms and plane (notably in London), and certain herbs, viz., the plantains, docks and sorrels, and possibly common nettle. It is necessary before forming a diagnosis on a particular patient's hay-fever to be able to show that his symptoms coincided with or at least fell within the period during which he was actually inhaling the pollen concerned. For this purpose reference to the frequency diagrams is essential."

GROWTH AND TITRATION OF THE VIRUSES OF FOOT-AND-MOUTH DISEASE AND VESICULAR STOMATITIS IN KIDNEY MONOLAYER TISSUE CULTURES

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AN accurate method of virus titration has been developed by Dulbecco. The method involves the counting of plaques produced by the destructive action of the virus on susceptible cells grown as a monolayer in tissue culture, and has been applied to the titration of the virus of equine encephalomyelitis, Western type (*WEE*), on chick embryo monolayers[1] and of poliomyelitis virus on monkey kidney monolayers[2]. Recently, my observation that the virus of vesicular stomatitis is cytopathogenic in tissue culture has led to the titration of this virus by the production of plaques on chick embryo monolayers and on ox embryo kidney monolayers. A necessary condition for the successful application of this technique is that the virus should multiply in the cells and produce destructive changes[2]. Since the virus of foot-and-mouth disease causes lesions in the infected animal similar to those caused by the virus of vesicular stomatitis, it was decided to investigate and compare the multiplication and destructive action of the two viruses in monolayer tissue cultures grown from kidneys of susceptible animals, and in particular to see if the accurate method of plaque counting could be applied to the titration of the virus of foot-and-mouth disease.

The method of preparation of the tissue cultures followed closely that described by Dulbecco and Vogt[2], including the solutions used. Kidneys of ox embryo, calves and pigs were obtained fresh from the abattoir. The capsule was removed and the cortex cut into small pieces, washed in warm phosphate-buffered saline, *p*H 7·5, and digested in 0·3 per cent trypsin in phosphate-buffered saline. The cell clusters thus obtained were washed three times in phosphate-buffered saline, and after a final centrifugation of three minutes in a calibrated centrifuge tube at 500 r.p.m. the packed cells were suspended in a hundred times their volume in a mixture consisting of 6 per cent ox serum and a synthetic solution (Waymouth, C., personal communication) which contained phenol red in a concentration of 0·0015 per cent. 10-ml. amounts were pipetted into 80-mm. Carrel flasks or 6-oz. flat-sided 'Pyrex' bottles, and the cultures were incubated at 36° C. Antibiotics were added to all solutions (100 units penicillin and 100 μgm. streptomycin per ml.); the supernatant fluid was changed every 48 hr. Patches of epithelial cells were observed on the second day and a continuous cell layer formed in four to eight days; ox embryo kidney and calf kidney cultures took less time to form the monolayer than the pig kidney cultures. The cell sheet consisted mainly of epithelial cells; but fibroblasts were present especially after long incubation.

The strains of virus used were as follows:

Foot-and-mouth disease. (1) Strain 997 of Waldmann *C* type (*C* 997). This strain, originally recovered from an outbreak of the disease in cattle in Great Britain, has been maintained for three years by passage in surviving epithelial tissue from the tongues of cattle. A filtrate of this culture virus was used to initiate the series of passages in the ox embryo kidney cultures. (2) Strain *M* 11, Vallée *O* type (*M* 11). This strain was originally recovered from an outbreak of disease in cattle in Mexico. A filtrate of tongue epithelium suspension from the twelfth cattle passage was used for calf kidney cultures. Virus of the same cattle passage was passaged four times in pigs, and a filtrate of the fourth-passage foot epithelium was used as starting material for the infection of the cells of the pig kidney cultures.

Vesicular stomatitis. A strain of virus of the Indiana type (*Ind. C*) maintained by passage in hen eggs for several years. Pooled egg fluid was used as a source of virus.

Serial passage in tissue culture was made by transferring the supernatant fluid of an infected culture, diluted with phosphate-buffered saline, to a fresh tissue culture. At 24-hr. intervals the cultures were examined under a low power of the microscope, and the supernatant fluid withdrawn for titration. In the case of the virus of foot-and-mouth disease, the titration was carried out by the intraperitoneal inoculation of 7-day old mice[4] with the appropriate serial dilutions and in later experiments by the plaque-count method on pig kidney cultures. The virus of vesicular stomatitis was titrated by the plaque-count method using chick embryo monolayers[1]. The overlay for the cultures consisted of 1·8 ml. of 2·8 per cent washed agar, 1·8 ml. of two-fold Earle's saline[5], 1·2 ml. of synthetic solution and 0·75 ml. of ox serum.

In Table 1 are shown the details of the titres obtained at each passage of the virus of foot-and-mouth disease, strain *C* 997, in cultures of ox embryo kidney and calf kidney together with the dilution at each passage. Evidence of multiplication of the virus is clear, since

Table 1. MULTIPLICATION OF THE VIRUS OF FOOT-AND-MOUTH DISEASE, STRAIN *C* 997, IN OX EMBRYO KIDNEY CULTURES AND IN CALF KIDNEY CULTURES

Source of virus	Passage	Time after inoculation (hr.)	Dilution from previous passage or filtrate	Titre (mouse *ID*50/ml.)
Filtrate of supernatant culture fluid of surviving tongue epithelium		42		$3·3 \times 10^4$
Ox embryo kidney cultures	1st	48	1 : 100	$3·3 \times 10^4$
Ox embryo kidney cultures	2nd	24	1 : 50	$> 10^8$
Ox embryo kidney cultures	3rd	24	1 : 50	10^8
Ox embryo kidney cultures	4th	24	1 : 100	10^7
		48		10^8
Filtrate of above	4th	24	1 : 100	10^8
Calf kidney culture	1st	21	1 : 10	$5·3 \times 10^8$
		44		$3·3 \times 10^8$
Filtrate of above	1st	21	1 : 100	$3·3 \times 10^4$
Calf kidney culture	2nd	24	1 : 20	8×10^6
" " "	3rd	24	1: 50	6×10^7
" " "	4th	24	1 : 50	6×10^6
		Total dilution		$1·25 \times 10^{17}$

after four passages in ox embryo kidney cultures and four in calf kidney cultures the titre at 24 hr. was 6×10^6 mouse *ID*50 per ml., although the original inoculum had been diluted by a factor of $1{\cdot}25 \times 10^{17}$. On microscopic examination of the infected cultures, small clusters of necrotic debris could be seen lying among the cells of the monolayer; but the cells were unaffected and continued to metabolize as shown by the change in colour of the phenol red in the medium. Some cultures in which multiplication had occurred were fixed and stained with hæmotoxylin and eosin after 48–72 hr. incubation. In these cultures the cells were less numerous than in control cultures without virus, but showed no gross pathological change. Epithelial cells and a few fibroblasts could be detected in both sets of cultures.

In the course of three passages in calf kidney cultures, the original inoculum of the virus of foot-and-mouth disease, strain *M* 11 (titre $2{\cdot}1 \times 10^3$ mouse *ID*50 per ml.), was diluted by a factor of 5×10^6, and the titre of the third passage at 24 hr. was 6×10^6 mouse *ID*50 per ml. The infected cultures showed the same change as that described for strain *C* 997, namely, clusters of necrotic tissue lying among healthy cells.

The virus of vesicular stomatitis, strain *Ind. C*, an egg-passaged strain, multiplied readily in calf kidney cultures. The titre of the second passage at 24 hr. was 2×10^7 plaque-forming doses/ml., whereas the initial titre was 7×10^3 plaque-forming doses/ml. In contrast to the action of the virus of foot-and-mouth disease in calf kidney cultures, the increase of the virus of vesicular stomatitis, strain *Ind. C*, was accompanied by destruction of all cells. 24 hr. after the addition of a small amount of virus, patches of round cells could be seen among the healthy cells in the monolayer, and by 48 hr. no cells remained on the glass surface of the culture flask, but round cells and necrotic debris were floating in the medium. The addition of a large amount of virus caused destruction of the cells by 24 hr. All types of cell in the culture appeared to be affected.

The virus of foot-and mouth disease, strain *M* 11, derived from the fourth-passage foot epithelium of the pig multiplied readily in pig kidney cultures. Titres not less than 10^6 mouse *ID*50/ml. were consistently recorded at each passage after 24 hr., and at the eighth passage the titre was $5{\cdot}9 \times 10^6$ plaque-forming doses/ml., although the original inoculum (titre $2{\cdot}1 \times 10^3$ mouse *ID*50/ml.) had been diluted by a factor of 1×10^{25}. From the first passage onwards the multiplication was accompanied by destructive changes in the culture. The epithelial cells lost their polygonal shape, became round and floated off the glass into the medium. Not all the epithelial cells were affected at the same time, but by 48–72 hr. only a few fibroblasts remained attached to the glass surface. Dilutions of the sixth-passage virus in phosphate-buffered saline were used to infect cultures, and after ½ hr. adsorption at 36° C. the monolayers were covered with an agar overlay. After 48 hr. incubation they were stained with a 1/20,000 solution of neutral red in Earle's saline[5]; on removal of the solution, plaques could be seen. They appeared as pale areas of irregular shape 1–4 mm. in diameter, surrounded by the living cells which had been stained by the neutral red. Microscopic examination showed that the central zone of the plaque consisted of unstained necrotic debris; around it could be seen unstained round cells, similar to those already described, and strands of stained epithelial cells and fibroblasts which, projecting towards the centre among the round cells, gave the plaque its irregular outline. Plaques have also been produced at the eighth and subsequent passages, and titrations performed so far appear to give support to the demonstration by Dulbecco and Vogt[2] of a linear relationship between number of plaques and virus concentration. In Table 2 is set out the number of plaques obtained at each dilution of the eighth-passage virus. Although many comparative titrations have not been made, the titres obtained by mouse inoculation and by plaque count are in fair agreement. For example, the titre of the eighth passage by plaque count was $5{\cdot}9 \times 10^6$ plaque-forming doses/ml. and by mouse inoculation it was 10^7 mouse *ID*50/ml. Both the destructive effects of the virus on the cells of the monolayer and the formation of plaques can be inhibited by the addition of immune serum to the virus, indicating that both effects are produced by the action of the virus. Virus from the fourth and sixth passage inoculated into pigs caused the appearance of typical lesions of foot-and-mouth disease.

Table 2. Multiplication of the Virus of Foot-and-Mouth Disease, Strain *M* 11, in Pig Kidney Cultures: Number of Plaques at each Dilution of Virus

Source of virus	Dilution of virus (0·1 ml.)	No. of plaques per culture	Average	Titre (plaque-forming dose/ml.)
M 11 Pig kidney culture 8th passage 24 hr.	$1:10^3$	Confluent	—	—
	$1:10^5$	Confluent	—	—
	$1:10^4$	74, 42	58	$5{\cdot}8 \times 10^6$
	$1:10^5$	7, 5	6	6×10^6

The virus of foot-and-mouth disease, strain *C* 977, from the fourth passage in calf kidney culture was used as inoculum for pig kidney cultures; the titre of the fourth-passage organism at 20 hr. was 10^6 mouse *ID*50/ml., although the original inoculum (titre $5{\cdot}3 \times 10^5$ mouse *ID*50/ml.) had been diluted by a factor of 4×10^{11}. During its multiplication, strain *C* 997 produced destructive changes on the cells of the culture similar to those described for strain *M* 11. An attempt at the third passage to produce plaques was successful, and they showed no apparent difference from those caused by strain *M* 11.

The behaviour of the virus of vesicular stomatitis, strain *Ind. C*, on pig kidney cultures resembled closely its behaviour on the calf kidney cultures. A titre of $8{\cdot}4 \times 10^7$ plaque-forming doses/ml. was obtained at the second passage after 42 hr., although the original inoculum derived from the second passage in the calf kidney culture (titre $5{\cdot}7 \times 10^7$ plaque-forming doses/ml.) had been diluted by a factor of 5×10^7. Multiplication of the virus was accompanied by cell destruction from the first passage onwards.

The specificity of the viruses used was checked by complement fixation tests on infected cultures or on virus suspensions from susceptible animals used in titration.

The fact that multiplication of the viruses of foot-and-mouth disease and vesicular stomatitis has been shown to occur in monolayer tissue cultures of the calf and pig kidney suggests the possibility that the viruses might multiply in the kidneys of infected animals. However, no gross pathological changes which could have been taken as evidence of multiplication have been described, and although the virus of foot-and-mouth disease has been demonstrated in the kidneys of animals slaughtered at the height of infection, the amount of virus present was never greater than

could be accounted for by the blood present in the organ[6].

The difference in cytopathogenicity *in vitro* of the two viruses is interesting in view of the similarity of the site and type of lesions in the infected animal. The virus of vesicular stomatitis grew well in all the cultures, destroyed all types of cells present, and produced round plaques on ox embryo kidney monolayers (unpublished observations, 1954). The virus of foot-and-mouth disease grown in the calf kidney cultures caused little damage to the cells, and consequently the calf kidney monolayers were not suitable for plaque production. In the pig kidney cultures the virus destroyed the epithelial cells and plaques could be produced. The presence of a few fibroblasts resistant to destruction by the virus gave the plaques the irregular outline referred to above; but this should not seriously detract from the usefulness of the plaque count method for the titration of the virus.

The strains of the virus of foot-and-mouth disease employed were both 'cattle' strains in that they were recovered originally from field outbreaks in cattle and have been maintained since by passage only by inoculation of cattle or by culture in cattle tissue. Strain *M* 11, which has been used in other experiments in this Institute, has proved to be highly invasive for cattle, producing regularly an extensive generalized infection in contact exposure tests. In pigs, on the other hand, it has been found recently in contact exposure tests that *M* 11 is of low invasiveness for pigs, inapparent infection being more frequent than overt infection. It seems surprising, therefore, that the cytopathogenic changes were greater in pig kidney cultures than in calf kidney cultures. Although only two strains of the virus of foot-and-mouth disease have been used, it appears likely that this difference is due rather to some property of the tissue culture than of the virus strain.

The differences between the pathological changes produced by the viruses of foot-and-mouth disease and vesicular stomatitis in the kidney monolayers studies are of fundamental interest for research on the virus–cell relationship. Both viruses have multiplied readily in spite of these differences, and these cultures therefore suggest a source of material other than tongue epithelial tissue for virus production; but it is perhaps the use of the pig kidney monolayer cultures for the accurate titration of the virus and the isolation of pure-line strains of virus that are of most immediate application in foot-and-mouth disease research.

It may be noted that the virus of vesicular exanthema, which produces similar lesions in pigs, has been successfully grown with cytopathogenic changes in pig kidney tissue cultures by McClain *et al.*[7] and now by me. In addition, I have demonstrated, with two strains of the virus of different immunological type, the formation of plaques with the agar overlay method. The plaques resemble in morphology those produced by the virus of foot-and-mouth disease. Titrations of the virus of vesicular exanthema have been carried out by the plaque count method, and I have shown also that the effects of the virus on the cells of the monolayer and the formation of plaques were inhibited by the addition of the appropriate type-specific immune serum, to the virus.

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BLOOD COUNTS IN DOMESTIC ANIMALS IN THE GOLD COAST

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IN the course of investigations carried out at our laboratories at Achimota on the trypanosomes of domestic animals in the Gold Coast, it has been found that the hæmatological values obtained for goats and sheep healthy in appearance and apparently free from trypanosomes differ appreciably from those given by Drastisch[1] and Wintrobe[2]. It must be emphasized that their figures are based on a total of six goats and five sheep compared with our own observations on nineteen goats and nine sheep, with a total of 187 counts in the former and 41 in the latter. In our hæmatological studies, there were two distinct types of both goats and sheep: (*a*) West African dwarf goat, (*b*) West African long-legged goat (sahel), (*c*) West African dwarf forest sheep, and (*d*) West African long-legged sheep. These breeds of goats and sheep constitute the main types encountered in the Gold Coast and indeed over the greater part of West Africa. The West African dwarf goat and the West African dwarf forest sheep originally occurred in the whole area of West Africa south of lat. 14° N., whereas the West African long-legged goat and the West African long-legged sheep had their origin farther northwards into the interior of Africa.

The hæmatological values given in Tables 1–4, and corpuscular constants shown in Table 5 (for fifteen West African dwarf goats and four West African long-legged goats and based on 167 and 20 blood counts, respectively), are in general agreement with those of Drastisch and Wintrobe. The methods of determination used in the present work were: red blood cell and leucocyte counts, Dacie[4]; packed cell volume and erythrocyte sedimentation rate, Wintrobe[2]; hæmoglobin, M.R.C. grey wedge photometer[5]; anticoagulant used, double oxalate mixture[6]. It would

Table 1. Blood Counts in 15 West African Dwarf Goats

Index of animal	No. of counts	Red blood cells (mill./c.mm.)	Vol. of packed red cells (ml./100 ml.)	Hæmoglobin (gm./100 ml. blood)	Leucocyte count (thousands/c.mm.)
G.D. 8	63	10·44 ± 1·77	20·9 ± 2·93	7·9 ± 0·83	13·36 ± 3·17
G.D. 5	18	12·61 ± 1·86	25·1 ± 3·14	9·2 ± 0·91	13·82 ± 3·92
G.D. 41	4	12·92	22·0	8·6	12·33
G.D. 43	4	12·10	25·0	9·1	17·30
G.D. 52	11	13·29	24·3	9·1	14·30
G.D. 53	11	14·96	28·8	10·6	14·31
G.D. 79	8	12·36	28·5	12·4	11·99
G.D. 81	2	12·04	26·5	8·5	12·40
G.D. 86	1	12·89	26·0	8·8	15·05
G.D. 92	2	11·92	25·5	8·2	14·20
G.D. 94	2	11·99	23·0	7·4	14·10
G.D. 61	24	14·35 ± 1·48	32·7 ± 2·57	10·7 ± 0·85	13·61 ± 2·50
G.D. 26	7	12·02	21·6	8·1	18·67
G.D. 58	1	14·92	29·0	10·4	13·25
G.D. 63	9	12·77	23·0	8·9	19·54
	167	12·77 ± 2·34	25·5 ± 4·58	9·2 ± 1·61	14·54 ± 3·28

Table 2. Blood Counts in 4 West African Long-legged Goats

G.L. 72	3	15·58	29·0	10·0	15·28
G.L. 74	11	11·89	25·0	7·9	12·65
G.L. 75	3	13·65	30·0	9·8	10·52
G.L. 87	3	12·65	26·0	7·9	12·53
	20	13·44	27·5	8·9	12·75

Table 3. Blood Counts in 3 West African Dwarf Forest Sheep

S.D. 3	1	10·75	24·0	11·1	18·30
S.D. 7	2	8·65	31·0	11·1	10·90
S.D. 9	2	10·98	31·0	10·4	13·48
	5	10·13	28·7	10·9	14·23

Table 4. Blood Counts in 6 West African Long-legged Sheep

S.L. 13	3	8·90	24·3	9·8	7·17
S.L. 14	3	7·47	24·7	9·4	6·60
S.L. 18	12	8·66	26·0	9·2	10·85
S.L. 20	3	9·51	26·0	9·9	8·47
S.L. 21	12	8·47	23·6	8·5	9·55
S.L. 22	3	8·22	30·7	9·0	8·92
	36	8·54 ± 1·35	25·9 ± 3·36	9·3 ± 0·62	8·59 ± 2·21

Table 5. Average Hæmatological Values for Goats and Sheep by Drastisch (ref. 1), Wintrobe (ref. 3) and Present Writers

Animal	Recorder	Red blood cells	Vol. of packed red cells	Hæmoglobin	Leucocyte count	Mean corpuscular volume	Mean corpuscular hæmoglobin	Mean corpuscular hæmoglobin concentration
Goat	Drastisch	18·70	30·0	9·8		16	8	32
Goat	Wintrobe	17·33	33·2	11·4	7·4	19	7	35
Dwarf goat	Present writers	12·77	25·5	9·2	14·54	19·97	7·20	36·08
Long-legged goat	" "	13·44	27·5	8·9	12·75	20·52	6·61	32·23
Sheep	Drastisch "	10·90	33·5	11·8		35	11	31
Sheep	Wintrobe	10·50	35·7	12·9	5·0	35	13	35
Dwarf sheep	Present writers	10·13	28·7	10·9	14·23	28·30	10·72	37·88
Long-legged sheep	" "	8·54	25·9	9·3	8·59	30·29	10·88	35·91

seem, therefore, that the low values for the number of erythrocytes recorded, in the third column of Table 5, for these goats in the Gold Coast are accurate standards for these animals in this region of West Africa.

The marked differences evident in column 7, Table 5, between the mean corpuscular volume of the erythrocytes of the sheep investigated by us and that cited for sheep by both Drastisch and Wintrobe are due to the much higher values recorded by them for the volume of packed red cells (column 4, Table 5). These figures, taken by themselves, indicate that the red blood corpuscles of the West African dwarf forest sheep and the West African long-legged sheep in the Gold Coast are smaller than those regarded as normal for sheep, at least, when based on determinations quoted by Drastisch and Wintrobe.

In addition to the hæmatological values included in Tables 1–5, the erythrocyte sedimentation-rate was also recorded in all cases, and it varied, irrespective of the breed of the animal, in the goat from 0 to 1·0 and in the sheep from 0 to 5·0 mm. in one hour. In many of the goats, the fragility of the erythrocytes was also measured in different strengths of sodium chloride solutions[3]. All of them showed a very high degree of fragility of their red cells, the hæmolysis being slight at 0·8 and virtually complete in all cases at 0·65 per cent concentration.

Judging from these results, and also from general observations made on the blood content of other domestic animals, particularly cattle and horses, in the Gold Coast, it would seem that apparently healthy animals in this territory either have an inherently lower hæmatological value than the normal standards, or that they suffer from the effects of some anæmia-producing factor or factors so far undiscovered. The anæmia might well be due to some dietary deficiency for normal blood production, or to a pathenogenic organism hitherto undemonstrated. It is noteworthy in this respect that similar findings have been recorded in Africans of the Gold Coast by Colbourne, Edington and Hughes[7]. Further, trypanosomes of various species, especially *Trypanosoma vivax* and *T. congolense*, frequently cause in farm animals in the Gold Coast, besides an acute type of trypanosomiasis, an insidious and chronic form of disease; this, although producing an anæmic condition, often proves exceedingly difficult to recognize clinically or by examination of blood smears for the presence of the parasites, even when repeated daily over many weeks.

No blood parasites were detected, however, at any time in the goats and sheep included in these studies, and the internal worms were entirely confined to nematodes, judging by the ova recovered in samples of the fæces. Even the nematode infections were light, the number of ova seldom exceeding 1,500 per gm. of fæces. As expected, *Haemonchus contortus* constituted by far the most abundant species.

[May 28

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Identity of Cephalosporin *N* and Synnematin *B*

A SPECIES of *Cephalosporium* isolated in Sardinia was reported, in 1948, to produce an antibiotic which inhibited the growth of a number of Gram-positive and Gram-negative bacteria[1]. This antibiotic, which was only obtained in a crude form, was not characterized chemically. In 1949 certain members of the genus *Cephalosporium*, including one that was believed to constitute a new species, were reported in the United States to produce a water-soluble antibiotic called synnematin[2]. In 1951 further studies were reported on the new species and its antibiotic, synnematin[3]. These studies included the determination of chemical and biological properties of the antibiotic. The new species was later named *Cephalosporium salmosynnematum*[4]. In 1951 work in England revealed that the *Cephalosporium* from Sardinia produced a family of antibiotics, cephalosporin *P* 1–5 inclusive, which could be extracted into common organic solvents, and a water-soluble antibiotic with quite different properties. The latter was named cephalosporin *N*[5]. Further work disclosed the presence of another antibiotic named cephalosporin *C* which is closely related to cephalosporin *N*[6].

In 1953 cephalosporin *N* was reported to be a new type of penicillin, and it was suggested that cephalosporin *N* and synnematin might be identical[7]. In the meantime, synnematin was separated into two components called synnematin *A* and synnematin *B*, the former being apparently less soluble in methanol than the latter[8]. Subsequent work on cephalosporin *N* showed that this substance was a penicillin the side-chain of which was derived from D-α-aminoadipic acid[9]. Cephalosporin *C* also contained sulphur and yielded D-α-aminoadipic acid on hydrolysis[6].

The toxicity of both cephalosporin *N*[10] and synnematin *B*[11] to laboratory animals is extremely low. Doses as large as 5 gm./kgm. have been given intravenously without noticeable ill-effects. Cephalosporin *N* has been reported to resemble benzylpenicillin in some of its pharmacological properties[10], and synnematin *B* has been used successfully for the treatment of *Salmonella* infections in mice, chicks and man[11].

We now wish to report that we have exchanged samples of highly purified cephalosporin *N* and synnematin *B* and have obtained strong evidence that the two substances are, in fact, identical. Assays in different laboratories have indicated that the cephalosporin *N* unit[12] is between six and nine times as large as the synnematin *B* unit[3]. The evidence for the identity of the substances may be summarized as follows:

(1) The two products showed the same relative activities (within the experimental error) against strains of *Staphylococcus aureus*, *Salmonella typhi*, *Salmonella typhimurium* and *Sarcina lutea*. The activity of both products was destroyed by incubation with penicillinase.

(2) The two products were indistinguishable, with respect to antibacterial activity, when run on paper chromatograms in a variety of solvent systems. In each case the activity was associated with the major ninhydrin-positive spot. Similarly, the products were indistinguishable when subjected to ionophoresis on paper at *p*H 7.

(3) After hydrolysis with acid, the sample of synnematin *B*, like that of cephalosporin *N*, showed two main spots on paper chromatograms, corresponding to penicillamine and D-α-aminoadipic acid respectively. D-α-Aminoadipic acid was isolated from the hydrolysate. Dinitrophenyl α-aminoadipic acid was isolated from a hydrolysate of the product obtained by allowing synnematin *B* to react with 1-fluoro-2 : 4-dinitrobenzene.

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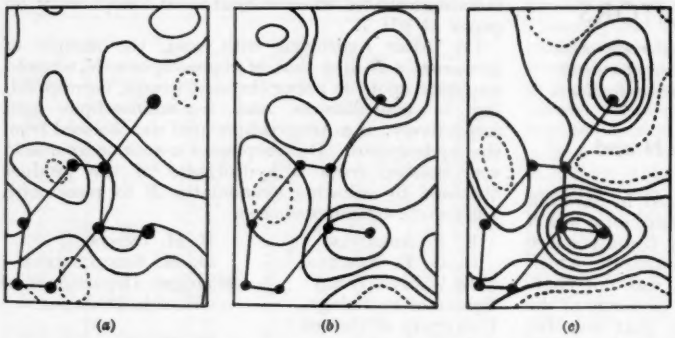
Some Observations on the Crystal Structure of a Chlorine-substituted Vitamin B_{12}

WE have recently obtained direct confirmation of the correctness of certain features of our outline structure of vitamin B_{12}[1] in a rather interesting way.

It has been shown by Ford *et al.*[2] that an *E. coli* mutant requiring B_{12} can produce biosynthetically, from factor *B* and various substituted benziminazoles, vitamin B_{12} analogues containing benziminazoles other than 5 : 6-dimethylbenziminazole. One of these, in which the two methyl groups are replaced by chlorine atoms, has since been prepared for us by Dr. K. H. Fantes and Mrs. C. H. O'Callaghan, of Glaxo Laboratories, by a method similar to the one previously used for obtaining the benziminazole analogue of vitamin B_{12}[3]. Air-dry crystals of this chlorine-containing compound give X-ray photographs which are exceedingly similar to those of air-dry vitamin B_{12}; only in a few cases, changes in the relative intensities of the weaker X-ray reflexions can be observed by eye. From measured intensities recorded on a Weissenberg photograph of one of the chlorine-containing crystals, we calculated a projection of the electron density down the crystal needle axis, [001], using signs based on the cobalt atom contributions previously found for air-dry B_{12} itself. The depth of the electron-density projection here is 16 A.; accordingly few, if any, of the atoms present can appear separately resolved. But at exactly the positions expected for the methyl groups from our earlier analysis, extra electron density appears



(a) (b) (c)

Fig. 1. Electron density over the benzene ring seen in projection down the c axis for (a) air-dried B_{12}; (b) chlorine-substituted B_{12}, calculated with terms having signs based on cobalt contributions alone; (c) chlorine-substituted B_{12}, calculated with terms based on signs derived through intensity changes on isomorphous replacement. Contours at intervals of 2 e/A^2 above the 4 e contour which is dotted

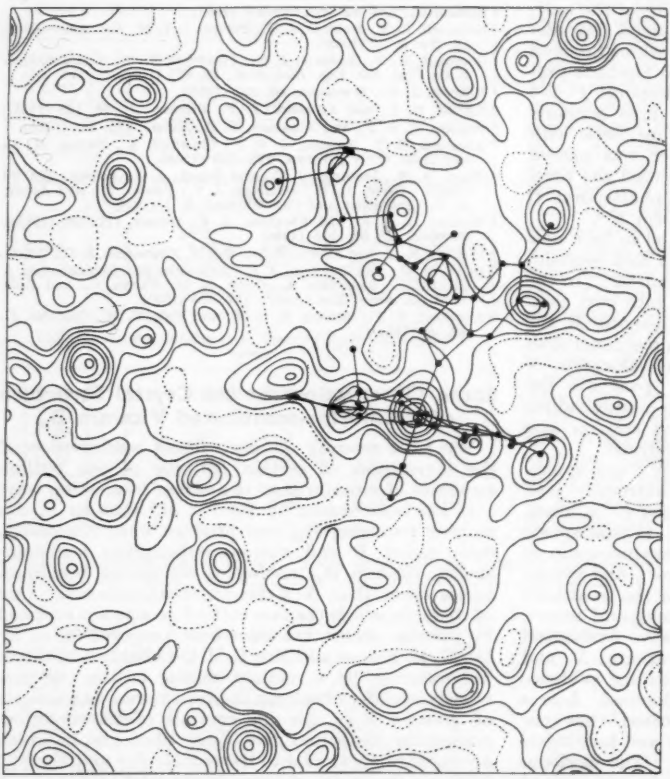


Fig. 2. Electron density calculated for chlorine-substituted vitamin B_{12} seen in projection down the c axis and corresponding with Fig. 1(c). The positions derived for atoms in the 'planar' group, benziminazole, ribose and phosphate groups in air-dried B_{12} crystals are drawn in

corresponding with the change methyl to chlorine (Fig. 1 'a, b), while the rest of the electron-density pattern is largely unchanged. If we now accept these positions as the sites of the methyl or chlorine groups, we can calculate precisely the changes to be expected in the structure factors from the changes in scattering factor methyl to chlorine. Direct comparison with the observed changes shows good general agreement and makes it possible considerably to improve the sign determination over that based on the cobalt atom positions alone; 5 terms change sign and 17 additional terms can be given signs, making it possible to insert 73 out of a total of 81 terms in a new electron-density calculation. The electron density projection shown in Fig. 1 c and Fig. 2 is the new, sign-determined, projection of electron density for the chlorine-containing vitamin.

These observations prove that the atoms of the benziminazole group are closely in the positions derived for them in the earlier work on vitamin B_{12} itself, with N3 directly linked to the cobalt atom. They also illustrate how sensitive the intensities of the X-ray reflexions are even to small changes in chemical composition and they confirm the reliability of the methods we are using for structure analysis. The absolute scale of the observed intensities, for example, we derived by the statistical method suggested by A. J. C. Wilson[4]. No modification of scale proved necessary to correlate the old observations on B_{12} itself with those of the chlorine-containing vitamin. Again, neither chlorine (atomic number 17) nor cobalt (27) has a high scattering factor relative to the total F_{000} of about 800 calculated for the whole B_{12} molecule + water of crystallization. But both these scattering factors, and that of 16 for the difference 2Cl–2Me, are of sufficient magnitude relative to the estimated statistical average $\bar{F}_{AH}$ of about 42, in the scale of one B_{12} molecule, to be used in phase determination. The present measurements illustrate very clearly the reality of the low electron density peak pattern observed in the three-dimensional distribution calculated for air-dry B_{12} with terms phased on cobalt contributions alone and previously used for atom placing; and the proof that this peak pattern was an accurate indication of the positions of the atoms of the benziminazole group gives us all the more confidence in accepting it as evidence for the structure of the chemically unknown part of the B_{12} molecule[5].

The use of micro-organisms for synthesizing heavy-atom derivatives for crystallographic purposes is not quite new. Dr. E. Kleiderer and Dr. O. Behrens (Lilly Laboratories) did very kindly prepare iodobenzylpenicillin by a similar fermentation process for crystallographic examination in 1946; only the fact that the structure of penicillin was by that time established made unnecessary the further investiga-

tion of this compound by X-ray analysis. It seems likely that this synthetic approach may prove useful in other still more complex investigations of natural products.

We are much indebted to Dr. K. Fantes, Mrs. O'Callaghan and Dr. E. Lester Smith for the crystals of the chlorine-substituted vitamin.

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An Effect of Antibiotics produced by Plankton Algae

The clear blue oceanic water in the tropics and subtropics, where the standing crops both of phytoplankton and zooplankton are extremely low—the reason why the water is so clear and blue—should on this account show very low organic productivity by the plankton algae. Measurements with the carbon-14 method have shown this to be true[1].

So-called 'light-and-dark bottle' oxygen experiments by Riley[2], verified by other workers, seem, however, to indicate that the areas with the clear, blue water should be some of the most productive sea areas of the world. Steemann Nielsen[1] therefore rejected the use of the oxygen method in clear oceanic water. The difference in oxygen consumption between light and dark bottles, which was assumed by Riley to be due to photosynthesis, may have nothing to do with this process. It was suggested that antibiotics produced by the plankton algae in the light reduce the intense bacterial activities occurring in the dark bottles as soon as natural sea water is enclosed in bottles. In ocean water from all depths, about 5 mgm. organic matter is present per litre. The intense bacterial activity does not occur if the water is *in situ* (Keys, Christensen and Krogh[3]). The presence of the surface at the inner walls of the bottles is responsible for the bacterial growth[4].

Laboratory experiments with the freshwater green alga *Chlorella pyrenoidosa* and the marine diatom *Thalassiosira nana* have now produced the experimental background for this suggestion. Two of these experiments are presented below.

(1) Normal culture medium for *Chlorella* containing 8 mgm. glucose and 4 mgm. peptone per litre was incubated with bacteria, and a definite very small number of *Chlorella*. The rate of photosynthesis per cell was measured in advance in a special experiment using a higher concentration of the alga but the same oxygen technique as in the main experiments. Normal 'light-and-dark bottle' oxygen experiments were carried out here lasting three days including three light periods (44 hr. altogether) alternating with three dark periods. The rate of photosynthesis during the whole experiment, computed from the special experiment and corrected for growth, was 0·024 ml. oxygen per litre.

Oxygen consumption in dark bottles	3·59 ± 0·02 ml. oxygen per litre
Oxygen consumption in light bottles	2·92 ± 0·03 ml. oxygen per litre
Reduction in oxygen consumption in light bottles compared with dark bottles	0·67 ± 0·04 ml. oxygen per litre

The oxygen consumption in the dark bottles is due to the respiration by the bacteria. The rate of this respiration is thus reduced in the light bottles. It is evident that the difference between the light and the dark bottles is not due to *Chlorella* photosynthesis, which constitutes only 3–4 per cent of this difference. In a corresponding series made simultaneously with bacteria but without *Chlorella* added, the oxygen consumption was the same in the light and in the dark bottles.

(2) Similar experiments were carried out with a culture of the marine plankton diatom *Thalassiosira nana* inoculated with bacteria from the Sound. In a 'light-and-dark bottle' oxygen experiment lasting three days (48 hr. in the light), oxygen consumption was 4·96 ml. per litre in dark bottles and 4·34 ml. in light bottles. The reduction in light bottles compared with dark bottles was 0·62 ml. oxygen per litre. According to experiments made with a 300-times higher concentration of the diatom during 4 hr., the rate of photosynthesis per 48 hr. in the main experiment—corrected for growth—was 0·035 ml. oxygen per litre. Photosynthesis presents thus only 5·7 per cent of the difference between the light and dark bottles.

The experiments presented show that the presence of algae, presumably due to production of antibiotic, effects a reduction in the oxygen consumption of the bacteria in the light bottles. The production of antibiotics by plankton algae has been shown, for example, by Pratt *et al.*[5]. It was verified during the present investigation that antibiotics may be found in filtrates from algal cultures.

Whereas in oligotrophic water in Nature the reduction of bacterial respiration due to antibiotics makes the oxygen technique inapplicable for measuring organic productivity, the influence in eutrophic water must be very limited.

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A Possible New Vitamin A_1 Isomer in the Eyes of Crustaceans

In a recent communication, Kampa[1] reports a new photosensitive pigment in the eyes of euphausiid crustaceans. This prompts the recording of some observations at this laboratory from a series of investigations of vitamin A components in marine animals.

During this investigation we recently obtained a fresh sample of the deep-sea prawn, *Pandalus borealis*. The vitamin A content of the eyes of this decapod was determined by our routine method, namely, chromatography of the unsaponifiable matter mainly according to Gridgeman *et al.*[2]. The ultra-violet absorption curve departed to the left from the expected vitamin A_1 curve, $E_{310m\mu}/E_{328m\mu} = 0{\cdot}926$, $E_{333m\mu}/E_{328m\mu} = 0{\cdot}823$, and $E_{350m\mu}/E_{328m\mu} = 0{\cdot}424$. The vitamin A content was 150 I.U. per gm. fresh tissue. No vitamin A_2 was present, $E_{693m\mu}/E_{618m\mu}$ in the Carr–Price reaction being 0·005.

The maleic acid anhydride reaction, according to Robeson and Baxter[3], gave 70·6 per cent recovery, showing mainly or only *cis*-configuration. The prawns had been exposed to daylight during sampling and removing of the eyes, thus complete bleaching may be assumed. These results, together with the biological potency of 50 per cent compared to the chemical estimations as observed by Fisher *et al.*[4], point to the occurrence of a new vitamin A_1 isomer in crustacean eyes, possibly the Δ-3.5-di-*cis*-isomer, postulated by Hubbard and Wald[5]. Unfortunately, fresh samples of these crustaceans cannot be obtained until next winter, thus further investigations have to be postponed.

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High-potency Vitamin A_2 Oils from Indian Freshwater Fish

Vitamin A_1 occurs predominantly in the liver oils of marine fish, whereas vitamin A_2 is found largely in freshwater fish liver oils. The mode of action of vitamins A_1 and A_2 is not certain; but their role in vision, giving rise to the pigments rhodopsin and porphyropsin respectively, in the retina is now well established[1]. Due to paucity of high-potency freshwater fish liver oils as well as their labile nature, vitamin A_2 has not yet been obtained in a crystalline form. The spectroscopic properties[2,3] and the biological activity[4] of vitamin A_2, which is approximately 40 per cent of that of vitamin A_1, have been determined with the purest preparation obtained.

Data on the vitamins A content of Indian freshwater fish liver oils measured spectrophotometrically are not available, and not much is known of the relative distribution of vitamins A_1 and A_2. The present communication gives the result of work carried out on fish in large freshwater reservoirs in the States of Mysore and Madras.

Fresh livers were ground with acid-washed sand and anhydrous sodium sulphate, and oil was extracted with light petroleum (40–60°). The combined extracts were reduced in bulk at low pressure (yield of oil, approximately 5 per cent). An aliquot of the oil was saponified, made up to a known volume in spectroscopic *cyclo*hexane, and absorption spectra and colour test were determined without delay using a Beckman spectrophotometer. The assay of the oil was carried out according to the standard spectrophotometric method of Cama and Morton[3]. The vitamins A_1 and A_2 content of these highly potent oils are recorded in Table 1. Investigations by chromatographic technique[5] on the oils were also carried out using 5 per cent weakened Merck alumina. The results on one oil are recorded in Table 2.

From the results in Table 1, it is evident that vitamin A_2 predominates largely over vitamin A_1 (A_2/A_1 approximately 9/1). Moreover, the oils have a very high vitamin A_2 content relative to oils previously reported in the literature[6]. Chromatographic investigations show that most of the vitamin A_2 in the oil is present in the ester form without the simultaneous presence of vitamin A_1 ester (presence of 693 mμ band and absence of 620 mμ band with the antimony trichloride colour test on the vitamin A_2 ester fraction). Vitamin A_1 is present in the alcohol form only, and a small amount of vitamin A_2 alcohol was also present. This was also confirmed for the other two highly potent oils.

Table 1. Spectroscopic Data on Freshwater Fish Liver Oils using Ultra-violet Spectra and the Antimony Trichloride Colour Test

Name of species	E(1%, 1 cm.) 351 mμ vitamin A_2	E(1%, 1 cm.) 693 mμ vitamin A_2	E(1%, 1 cm.) 620 mμ vitamin A_1	Corrected E(1%, 1 cm.) 351 mμ vitamin A_2	Corrected E(1%, 1 cm.) 325 mμ vitamin A_1
1. *Callichrous bimaculatus*	259	618	329	211	26
2. *Ophiocephalus striatus*	265	582	311	200	25
3. *Wallago attu*	127	307	157	106	11

Table 2. Spectroscopic Properties of Fractions obtained by Chromatography of *Wallago attu* Oil on 5 per cent Weakened Merck Alumina

Fraction	Solvent	Max. (mμ)	E(1%, 1 cm.)* 350 mμ	Component
1	Light petroleum (40–60° C.)	350, 370, 390	0·121	Anhydrovitamin A_2
2	„ „	290, 336·7, 345	1·72	—
3	„ „	285, 350	86·80	Vitamin A_2 ester
4	2% ether-light petroleum	330	14·00	Vitamin A_1 alcohol
5	5% „ „	330, 350, 370, 390	2·25	—
6	10% „ „	285, 350	12·65	Vitamin A_2 alcohol
7	15% „ „	330, 355, 370	0·933	—
8	20% „ „	336·7, 350	0·844	—
9	Ether	330	1·81	Oxidized vitamins A_1 and A_2?

Gross E(1%,1 cm.) at 350 mμ of the whole oil, 127·0. Total E(1%,1 cm.) at 350 mμ of the fractions, 121·128.
* Expressed in terms of weight of original oil.

Attempts are being made to extract large quantities of such typical oils for further detailed studies and characterization.

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Adrenaline and Noradrenaline in Tissues of Normal, Insulin-treated, and Adrenalectomized Rats

ADRENALINE and noradrenaline have been estimated in nine rat tissues using an extension of the method of Weil-Malherbe and Bone for blood[1-3]. Satisfactory evidence for the specificity of the procedure has been obtained from comparisons with biological assay and by paper chromatography. The mean concentrations of noradrenaline and adrenaline in rats with a mean weight of 235 gm., and the means of the percentages of adrenaline in the mixture of amines (referred to below as 'adrenaline/catechol ratio') are shown in Table 1. The latter is both higher and more uniform than has been found by other workers and corresponds with the higher 'adrenaline/catechol ratio' found by Weil-Malherbe and Bone in blood[2,3]. The distribution of noradrenaline does not appear to support the current hypothesis that in general its concentration can be correlated with the density of adrenergic nerve fibres[4,5].

Table 1

Organ	Noradrenaline (mμgm./gm.)	Adrenaline (mμgm./gm.)	Adrenaline (per cent)
Heart (20)*	530 ± 47·7	179 ± 19·0	25·9 ± 1·86
Brain (6)	458 ± 53·8	212 ± 8·05	30·7 ± 1·71
Spleen (8)	230 ± 45·9	74·4 ± 12·9	25·4 ± 2·62
Diaphragm (20)	219 ± 12·0	54·1 ± 6 53	19·8 ± 2·12
Kidney (20)	158 ± 17·3	42·7 ± 5·00	21·9 ± 1·48
Liver (20)	87·1 ± 7·23	24·6 ± 3·64	21·0 ± 1·68
Retroperitoneal fat (8)	62·0 ± 13·8	20·2 ± 5·57	23·1 ± 3·79
Lung (8)	61·8 ± 7·33	22·9 ± 1·57	28·0 ± 2·78
Leg muscles (20)	52·4 ± 3·90	15·0 ± 1·53	22·4 ± 1·89

* Number of estimations

The effects of insulin on the concentrations of adrenaline and noradrenaline in heart, kidney, liver, diaphragm and leg muscles have been investigated by analyses carried out 2½ hr. after subcutaneous injection of 7 units insulin/100 gm. body-weight. Insulin produced significant increases ($P < 0{\cdot}01$ or $0{\cdot}001$) of the 'adrenaline/catechol ratio' in all five organs. There were significant increases ($P < 0{\cdot}001$) in the absolute concentrations of adrenaline in heart and kidney (64 and 42 per cent respectively), and a significant increase (23 per cent) of noradrenaline in the heart. The increased concentrations of adrenaline brought about by insulin were not nearly so marked as those found by Hökfelt[6] in the heart and liver of rats; this may be largely due to his lower initial concentrations of adrenaline. In contrast also to his findings, there were only probably significant differences between the effects of insulin actions of ½, 2 and 3½ hr. duration.

The concentrations of adrenaline and noradrenaline in heart and kidney were investigated six weeks after bilateral demedullation, and three to four weeks after bilateral adrenalectomy in untreated rats and in rats given insulin. Both operations reduced the adrenaline concentrations of heart and kidney, and in kidney the noradrenaline concentration was also reduced; in the heart it was increased. The greatest change was a 31 per cent loss of noradrenaline in the kidney.

In demedullated and adrenalectomized rats, insulin did not significantly increase the adrenaline concentration of either heart or kidney ($P > 0{\cdot}1$), but still produced probably significant increases of the 'adrenaline/catechol ratios'. The altered effect of insulin on adrenaline concentration brought about by operation was very significant for heart muscle ($P < 0{\cdot}001$). In heart muscle, operation also significantly altered the effect of insulin on noradrenaline concentration, from an increase to a decrease. The changes of adrenaline and noradrenaline concentrations which are produced by insulin in hearts of normal rats seem therefore to depend on medullary secretion. This may be in contrast to kidney, in which operation changed, probably significantly, only one of the effects of insulin, namely, it reduced the usually large rise in adrenaline concentration.

The presence of fairly high concentrations of adrenaline and noradrenaline in heart and kidney some weeks after adrenalectomy seems to indicate the ability of the rat to synthesize or store these amines, either in the heart and kidney, or in other organs from which transfer takes place. Transfer to the kidney occurs in the course of excretion[6].

Three experiments have been carried out on the effect of age (weight) on the percentage of adrenaline in the mixture of catechol amines in the heart and kidney of normal rats and of rats given insulin. The 'adrenaline/catechol ratios' are shown in Table 2.

Table 2

	Mean weight of rat, 145 gm.	Mean weight of rat, 240 gm.	Difference
Heart (untreated)	21·2 per cent	26·5 per cent	+ 5·3
Heart (insulin)	33·6 ,, ,,	39·1 ,, ,,	+ 5·5
Kidney (untreated)	23·7 ,, ,,	33·1 ,, ,,	+ 9·4
Kidney (insulin)	35·2 ,, ,,	39·5 ,, ,,	+ 4·3

The 'adrenaline/catechol ratios' were higher in both the heart and kidneys of the older rats. This ratio in the kidney was less affected by insulin in the older rats than in the younger ones.

Experiments with cortisone are being carried out, and the results, together with the above findings, will be published in detail elsewhere. The work has been supported by a grant from the Medical Research Council.

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Studies on Transaminase and Decarboxylase catalysed by Extracts of the Silkworm, *Bombyx mori* L.

IN the course of work[1] on the transamination reactions between aspartate and α-ketoglutarate mediated by extracts of the gland and intestines of the silkworm, *Bombyx mori* L., an entirely new ninhydrin-positive spot with an R_F value different from either the glutamate produced or added aspartate was observed when the reaction mixture was resolved on Whatman No. 1 filter paper employing butanol/formic acid/water (10 : 2 : 5) as the solvent.

It was suggested that this additional spot represents a peptide produced by enzymic transpeptidation[2]; but further work on transpeptidation with glycyl peptides and glutathione as the substrates did not confirm this view. A more detailed examination has therefore been made of the circumstances giving rise to this additional spot.

A number of solvents were employed to achieve better separation of the various constituents encountered in this work. While solvent systems like 80·0 per cent aqueous pyridine or propanol could be successfully employed for resolving the new spot from the mixture of aspartate and glutamate, these two salts themselves were inseparable, and therefore water-saturated phenol was employed. After resolving the various constituents from the 'reaction mixture', the position due to the new spot, determined separately by running a test strip and staining it with ninhydrin, was eluted, hydrolysed and re-chromatographed; but the position of the spot on the second chromatogram did not alter and corresponded to α-alanine. On subjecting another aliquot of this sample and an authentic specimen of α-alanine to chemical deamination with nitrous acid[3], lactic acid was detected from the deamination reaction product, confirming the identity of this substance with α-alanine. The route of formation of α-alanine from aspartate is through β-decarboxylation, and therefore the enzyme which catalyses this reaction is termed β-decarboxylase.

Amino-acids active in these transamination reactions other than aspartate are α-alanine, phenylalanine and the amide of aspartic acid. Aspartate is by far the most active among these compounds. When asparagine is employed as the substrate instead of aspartate, transaminase activity is diminished by about 65·0 per cent. Decarboxylase is, however, completely inhibited, because the β-carboxyl group in asparagine is replaced by the amide linkage.

Further, there is no appreciable decarboxylation even with aspartate when the latter is employed alone as the substrate. Addition of traces of α-ketoglutarate ($M/2{,}000$) to enzyme–aspartate mixture in a buffer of *p*H 7·0 increases the activity to 400 per cent. This concentration of the keto-acid is so small that activity due to transamination is not appreciable and even not detectable. Dialysis of the crude extract against distilled water at 0° C. inactivates irreversibly the activity due to decarboxylase, but does not affect transaminase activity. The effect of carbonyl-trapping agents such as hydrazine, hydroxylamine and semicarbazide on both transaminase and decarboxylase are similar, and are inhibited to more or less the same extents. Addition of pyridoxal phosphate to dialysed enzyme extracts does not, however, restore the decarboxylase activity.

A similar enzyme system bringing about decarboxylation of aspartate in the β-position has been shown to occur in cell-free extracts and cell suspensions of *Cl. welchii SR* 12, which is also stimulated by the addition of traces of a large number of α-keto-acids[4].

The discovery of an enzyme system in the glands of the silkworm capable of converting aspartate to α-alanine is of particular significance from the point of view of the synthesis of precursors of silk fibroin. This mechanism secures for the organism an additional source of endogenous α-alanine, which constitutes about 20·0 per cent on the weight of silk.

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Effect of 8-Azaguanine on Enzyme Formation

The dependence of enzyme formation on nucleic acids has now been established by studies with disrupted *Staphylococci*[1]. It is not yet clear whether the presence of ribonucleic acid as such or the process of synthesis of ribonucleic acid is essential for enzyme synthesis. Gale and Folkes[1] found that the development of certain enzyme systems was enhanced by the presence of ribonucleic acid extracted from the cells, whereas such extracts were without effect in promoting the synthesis of β-galactosidase, which required the presence of a mixture of purines and pyrimidines and was abolished by ribonuclease. Pardee[2], studying the formation of β-galactosidase in mutants of *Escherichia coli* requiring uracil, found that enzyme formation only took place in the presence of added uracil and, if the supply of uracil was limiting, enzyme synthesis ceased as soon as the supply of uracil was exhausted. He concluded that ribonucleic acid synthesis was essential for enzyme formation, the finished nucleic acid being metabolically inert. Similar conclusions have been drawn by Spiegelman, Halvorson and Ben-Ishai[3] as a result of investigations on inducible enzyme synthesis in *Escherichia coli* and in yeasts.

It has been shown previously that the formation of the adaptive enzyme β-galactosidase in *Staphylococcus aureus* is inhibited by the purine analogues 2 : 6-diaminopurine and 8-azaguanine, the latter becoming incorporated into ribonucleic acid[4]. It was suggested that such incorporation rendered the ribonucleic acid non-functional in enzyme formation. It has now been found that the synthesis of catalase and glucozymase by *Staphylococcus aureus* is also sensitive to azaguanine under certain conditions. When enzyme formation takes place in intact washed cells which have been grown anaerobically in glucose, and then incubated in a medium containing salts, amino-acids, glucose and galactose, the formation of β-galactosidase and catalase is almost completely suppressed by 100 μgm. azaguanine/ml. If glucose is omitted from the incubation mixture, incorporation of azaguanine is decreased and inhibition of enzyme formation lessened. Fig. 1 shows the effect of adding azaguanine to the incubation mixtures at intervals during the synthesis of β-galactosidase.

If the analogue is added at the beginning of the experiment, no enzyme formation occurs; if it is added after induction has taken place, enzyme formation is inhibited and ceases soon after the addition. Similar results have been obtained for the formation of either catalase or glucozymase, under appropriate conditions.

The inhibition of enzyme formation by azaguanine can be reversed by the further addition of guanine, xanthine or hypoxanthine. Reversal is not obtained

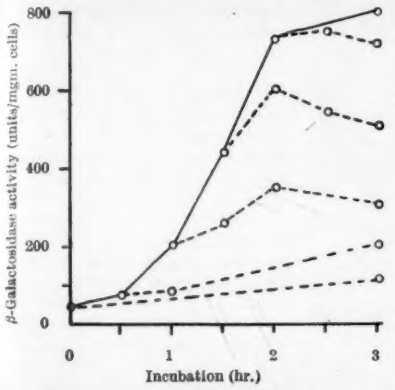

Fig. 1. Effect of time of addition of azaguanine to systems synthesizing β-galactosidase. System comprised *Staph. aureus* (2 mgm./ml.), 17 amino-acids (400 μgm./ml. of each), glucose (1 mgm./ml.), galactose (20 mgm./ml.) in a buffered salts solution. Azaguanine (100 μgm./ml.) added at time 0, 0·5, 1·0, 1·5 and 2 hr. Formation of β-galactosidase in control system shown in full lines; formation of enzyme after the addition of azaguanine shown in broken lines

by uracil or thymine and only rarely by adenine. When the inhibition is reversed by guanine, the incorporation of azaguanine into the ribonucleic acid does not diminish but there is a considerable formation of new ribonucleic acid, as measured by the incorporation of ^{14}C-uracil. Reversal can be brought about by addition of guanine up to 90 minutes after the addition of the analogue; if incubation with azaguanine has taken place for longer than this period, no reversal of the inhibition of catalase formation can be obtained; reversal of the inhibition of β-galactosidase formation is still possible, although synthesis occurs at less than the control rate after addition of guanine.

In the case of glucozymase formation, sensitivity to azaguanine varies with the phase of culture of the cells used for the experiment. Fig. 2 shows that synthesis of glucozymase in cells harvested during the exponential phase of growth is little affected by concentrations of azaguanine which abolish β-galactosidase formation. As growth ceases, the synthesis of glucozymase becomes more sensitive to azaguanine; the synthesis of β-galactosidase is completely sensitive to the analogue at all phases of growth. It seems probable that the synthesis of β-galactosidase is dependent upon a co-synthesis of ribonucleic acid, so that the present results are in agreement with the suggestions put forward by Pardee[2] and Spiegelman *et al.*[3]. Nevertheless, the results in Fig. 2 indicate that it is not possible to draw conclusions on protein synthesis in general from studies on inducible enzymes only, since the formation of glucozymase, under certain conditions, appears to be little dependent on coincident ribonucleic acid synthesis.

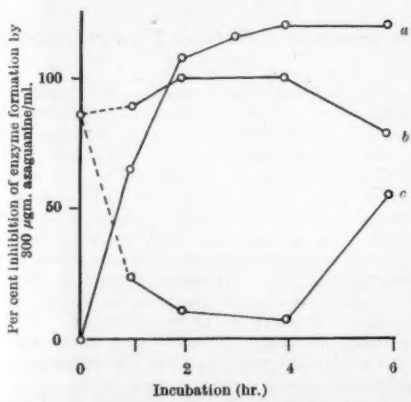

Fig. 2. Sensitivity of enzyme formation to azaguanine at various stages of growth. Cells growing in a glucose/casein hydrolysate medium. Samples were taken at times indicated and the ability of the cells to synthesize enzyme, in the system described for Fig. 1, in the presence or absence of azaguanine (300 μgm./ml.) determined. *a*, Growth; *b*, β-galactosidase formation; *c*, glucozymase formation

The above results can be correlated with the conditions necessary for the development of enzymes in disrupted *Staphylococci*, as described by Gale and Folkes[1]. They found that, whereas synthesis of glucozymase was stimulated by staphylococcal ribonucleic acid, β-galactosidase formation required a supply of purines and pyrimidines and was not affected by staphylococcal ribonucleic acid. All these findings could be explained on a basis of differing degrees of functional stability of the various nucleic acids concerned in the syntheses of different enzymes.

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Occurrence of Chitin in the Epicuticle of an Arachnid *Palamneus swammerdami*

In a previous communication[1], it has been pointed out that the epicuticle of *Palamneus swammerdami* conforms to the basic pattern suggested for insects in consisting of a non-chitinous lipoprotein layer overlaid by a layer of wax. However, more extended observations carried out since then indicate the presence of chitin in this layer, which is masked in some way so that it is not readily revealed by the usual histochemical tests. Blower[2] reported that in myriapods a layer of the cuticle, which he considered the outermost, resembles the epicuticle of insects in histochemical and staining reactions. Only the presence of chitin in it prevented him from homologizing it with the epicuticle. However, he ignored the presence of a layer external to the one he described as the outermost, for he doubted its histological validity, considering it as a diffraction effect. In a recent study of *Palamneus*[1,3], it has been shown that the layer referred to by Blower corresponds to the exocuticle and is distinct from the epicuticle, which lies external to this layer. Cloudsley-Thompson[4] also described in arachnids and myriapods a similar colourless epicuticle external to the tanned exocuticle. The present communication gives the evidence for the presence of chitin in the epicuticle.

The epicuticle of *Palamneus*, which can be separated by treatment of entire cuticle with chlorated nitric acid, is a thin whitish membrane. From a study

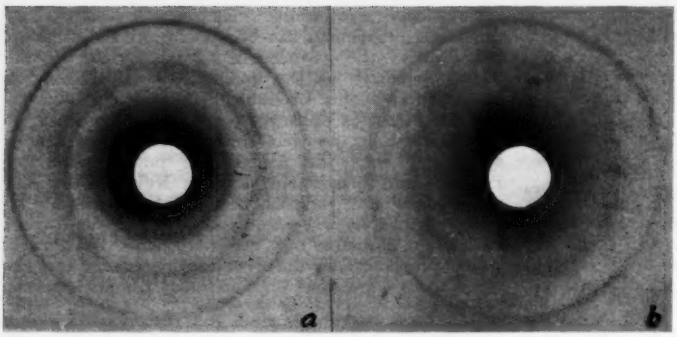

Fig. 1. X-ray diffraction patterns of (*a*) epicuticle of scorpion, and (*b*) purified chitin from cuticle of cockroach, both taken with the surface perpendicular to the X-ray beam under identical conditions (d = 5 cm., copper $K\alpha$ radiation)

of the sections of this membrane stained with Mallory, it was found that it agrees in all respects with the epicuticle already described[3]. X-ray diffraction patterns of this membrane taken with the X-ray beam both parallel and perpendicular to the surface showed the presence of spacings identical with those found for chitin[5]. A comparison of the diffraction pattern of the scorpion epicuticle with that of the cockroach, which is known to contain only protein, brings out clearly the entirely dissimilar nature of the two epicuticles, as the latter pattern shows no details except a central halo. On the other hand, the diffraction pattern of the scorpion epicuticle was found to show a remarkable similarity to that obtained with purified chitin (Figs. 1*a* and *b*). In view of this surprising observation, chemical tests were made on this membrane.

A portion of the membrane was prepared for the chitosan test by treating it with concentrated potassium hydroxide for 6 hr. at 180° C. On addition of iodine and sulphuric acid, it took up a deep orange colour. Controls prepared with crab cuticle showed that the epicuticle was dissolved by the potassium hydroxide treatment, and the endocuticle which survived was coloured deep violet, a characteristic of chitosan. On adding 3 per cent acetic acid the material from the crab treated with potassium hydroxide dissolved; but in the case of the scorpion epicuticle there was no such effect. However, the scorpion preparation reacted to treatment with concentrated nitric acid, by which it was disrupted. The results recorded above for the epicuticle of *Palamneus* differ in some respects from those obtained for chitin. But the fact that it is able to survive intact violent treatment such as is involved in the chitosan test is suggestive of the presence of chitin. It is remarkable that chitin is still present in the epicuticle, even though this layer has been isolated by subjecting it to prolonged treatment with chlorated nitric acid. Probably its combination with —S—S-bonded proteins may be responsible for this feature. This assumption is supported by the observation that treatment with alkaline sodium sulphide produces a disruptive effect on the material treated with potassium hydroxide. It has already been shown that alkaline sodium sulphide affects the —S—S-bonding in the epicuticle of *Palamneus*[3]. It is therefore suggested that the presence of a protein moiety in combination with chitin may be responsible for this material not giving a positive chitosan reaction.

Further confirmation of the presence of chitin was obtained by hydrolysing the epicuticular material in 4 N hydrochloric acid for 8½ hr. in a sealed tube at 100° C. The glucosamine content of the hydrolysate was estimated by the method of Elson and Morgan as modified by Palmer, Smyth and Meyer[6]. The estimated amount of glucosamine was found to be nearly the same as that given by purified chitin under the same conditions, as reported by Hackman[7]. A chromatographic analysis of the hydrolysate for amino-acids indicated the presence of glutamic acid. It appears that the epicuticle consists of chitin with a proportion of protein which, however, does not alter the chitin lattice structure.

A layer corresponding in all respects to the epicuticle of *Palamneus* appears to be present in *Scolopendra* also. The X-ray pattern of this layer is identical with that given by the epicuticle of *Palamneus*.

The implications of these observations in relation to the characteristic features of the epicuticle of arthropods will be discussed elsewhere.

We thank Prof. P. S. Sarma for facilities provided for chromatographic work.

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Measurement of Surface Pigmentation in Animals

An accurate method of measuring the pigmentation of human and other mammalian hair has been described[1]. This consists in dissolving the hair in urea, and, after dilution to a constant volume, measuring the extinction coefficient of the solution. The same procedure, without any modification, has been found to give reproducible results with feathers (domestic fowl), amphibian skin (common frog), fish skin (plaice) and insect scales (cabbage white butterfly and tiger moth). It seems probable that the method can be used for the estimation of surface pigmentation in all types of animals.

The work has been carried out with the aid of a grant from the Government Grant Committee of the Royal Society.

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A Method for sampling Arthropods and Molluscs from Herbage by Suction

THE insect population in herbage, for example, in rough grassland, is commonly sampled by sweeping. Other arthropods such as mites, centipedes, millipedes and also slugs and snails are obtained by trapping, hand-picking, or by removing part of the habitat for extraction in the laboratory. We have developed a new, more universal method, liable to less personal error than sweeping, which extracts a very high proportion of small invertebrates from rough matted grassland with a suction pump. There is no need to remove a part of the habitat, and the method could be applied widely.

The apparatus is a portable electric blower (Type *N.W.B.E.*) as supplied by Wolf Electric Tools, Ltd., London, and run on the mains supply. A metal barrel (10 in. long, 5·5 in. diam.) is attached to the intake, and on the lid of this barrel is a flexible hose ending in a hard rubber nozzle with a 1-in. aperture. A nylon collecting bag fits inside the barrel and is kept in place by the lid. The apparatus weighs 15·5 lb., and is easily carried.

For sampling, a metal cylinder 12 in. × 12 in. is pressed into the grass, the apparatus is switched on and the nozzle worked back and forth over the area within the cylinder. Two successive extractions each of two minutes with a two-minute interval between were found to be satisfactory. Table 1 shows the extraction-rates based on this procedure and on the numbers remaining behind in the herbage and in the upper few millimetres of soil within the metal cylinder (these being sorted by hand from the material brought back to the laboratory). From approximately 23 sq. ft., 2,945 insects, 1,606 other arthropods and 189 molluscs were extracted.

Table 1

Group	Mean extraction (per cent)	Group	Mean extraction (per cent)
Collembola—(Arthropleona)	99·3	Coleoptera (larvæ)	70·3
Collembola (Symphypleona)	100·0	Hymenoptera (Parasitica)	97·0
Thysanoptera	97·5	Diptera (adults)	99·2
Auchenorhyncha	98·1	Diptera (larvæ and pupæ)	75·5
Aphidoidea	99·8	Isopoda	98·3
Heteroptera	98·9	Acarina	90·2
Staphylinidae	92·2	Araneida	97·4
Ptiliidae	97·4	Diplopoda	86·1
Other Coleoptera	92·5	Chilopoda	66·7
		Mollusca	94·7

We shall be glad to supply further information. Full details will be published elsewhere.

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A Water-soluble Filter for trapping Airborne Micro-organisms

IN studies of airborne mould spores as a cause of respiratory allergy, there has been a need for a trap which would not only sample the air efficiently out of doors and give a measure of the number of spores per unit volume of air, but which would also allow the spores to be grown on culture media for identification.

Preliminary experiments early in 1952 indicated that a water-soluble 'wool' of sodium alginate could be used to trap spores. The sodium alginate is not available as a wool but has to be prepared from calcium alginate yarn. Initially yarns of four weights were tried (450/160; 150/60; 100/27; and 50/12, denier/filament (continuous), *Z* twist), but the most uniformly textured wool was produced by the 50 denier/12 filament yarn (from Messrs. Courtaulds, Ltd., Use-Development Organisation, 15 Cross Street, Manchester 2).

The calcium alginate yarn is cut into short lengths (5–10 mm.) and stirred into a relatively large volume of water to allow the yarn to untwist to its constituent filaments, then drained on a Buchner funnel. The resultant mass (calcium alginate 'wool') is soaked in hydrochloric acid (approximately *N*) until all calcium has been leeched out. (Test for removal of calcium by allowing a few drops of the acid solution to drip into a solution of ammonium oxalate—no precipitate indicates calcium removed.) The yarn is again drained off, suspended in 50 per cent alcohol and neutralized with sodium hydroxide. (Allow time for the strands in the centre of the mass to react with the alkali.) The yarn is now sodium alginate and is soluble in water. It receives several washes in 50 per cent alcohol, a final wash in absolute alcohol and is dried at room temperature. Best results are obtained by using throughout relatively large volumes of the suspending liquids, so that the alginate strands are always loosely suspended. The final product appears much like a wad of cotton wool, but it is soluble in water up to 1 part in 10 at room temperature. The higher concentrations are very viscous; but a 2 per cent solution in water has a viscosity about four times that of water, and a 1 per cent solution only about 1·5–2 times the viscosity of water. The wool may be sterilized dry at about 125° C.

The sodium alginate wool has been used for trapping airborne micro-organisms in the following way. The filter holder is a cylindrical brass tube 75 mm. long, 12 mm. diameter and 11 mm. bore. At one end the wall is bevelled on the outside to a sharp edge which during sampling is directed into the wind. Fixed transversely across the bore of the tube, 25 mm. from this sharp end, is a pair of crossed wires providing support for the alginate plug, which is rammed in at this end. (About 0·5 gm. of the wool packs into a plug approximately 10 mm. long, which is more than adequate.) The other end of the tube is connected to a pump. When the desired volume of air has been sucked through the plug, it is pushed out into sterile water which, after complete solution of the plug, is made up to the desired volume. Aliquots of this solution are plated out on culture media for incubation and counting.

For taking samples over several hours at the regular trapping site at St. David's Hospital, Cardiff, a wind-vane mounting similar to that described by Hirst[1] has been used for maintaining the sharp end of the filter tube facing the wind. The rate of suction through the filter is controlled at the mean wind velocity recorded at the site by a Casella three-cup anemometer, and thus sampling is approximately isokinetic[2].

To evaluate the efficiency of the plug in filtering off micro-organisms, several runs were made in which air after passing through the alginate plug was immediately bubbled through dilute agar solution. All this solution was plated out on media and incubated. These plates almost invariably remained sterile.

The alginate wool filter has proved to be very useful for sampling airborne fungi and bacteria which can be cultured. It is particularly suited for work with selective media, since aliquots of the solution of one filter can be plated out on several media. If desired, counts of non-culturable spores may be obtained by microscopic examination of the sediment obtained on centrifuging an aliquot of the solution of the filter. When the filter is used in conjunction with a small hand-operated pump, a simple, efficient and readily portable spore-trap results.

The work was performed at the Asthma and Allergy Research Unit, St. David's Hospital, Cardiff, during the tenure of a research grant from the Asthma Research Council, London. I thank Mr. H. A. Hyde and Dr. D. A. Williams for encouragement, Mr. R. H. McDowell of Alginate Industries, Ltd., for technical advice and Messrs. Courtaulds, Ltd., for supplies of calcium alginate yarn.

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A Direct Measurement of the Energy Locally Absorbed from a Gamma-Ray Beam

The energy locally absorbed in a material exposed to γ-radiation has usually been determined indirectly from measurements with an ionization chamber, using the Bragg–Gray formula. The calculation involves the use of two quantities the values of which are not accurately known: W, the average energy required to produce an ion pair, and ρ the ratio of the stopping powers of the material and the gas. The direct measurement of the energy absorbed presents some difficulties due to the small rise of temperature which is produced. If a dose corresponding to 300 r. is given to a sample of water, the temperature will rise by only $6{\cdot}7 \times 10^{-4}$ deg. C. However, the development of the thermally sensitive resistors known as thermistors has made possible the detection of a change of temperature of less than 10^{-5} deg. C.

In this laboratory a radiation calorimeter has been constructed. The sensitive part consists of a cylinder (2 cm. in diameter, 2 cm. in length) of a given material in which are imbedded a thermistor and a heating coil. The cylinder is suspended in an evacuated and aluminized glass vessel placed in a tank of water the temperature of which is controlled. To minimize the effects of heat transfer and self-heating in the thermistor, an identical dummy cylinder is suspended in another evacuated vessel but does not receive radiation. The thermistors are connected to the opposite arms of a d.c. Wheatstone bridge. A change in temperature of one of the cylinders produces an unbalanced voltage which is amplified and recorded on a self-balancing potentiometer. For calibration, a known amount of energy is dissipated in the cylinder by the heating coil. The thermistors used have a resistance of the order of 100,000 ohms and a negative temperature coefficient of − 4·7 per cent per deg. at 25° C. With the present arrangement it is possible to measure a change of temperature of 10^{-3} deg. C. with an accuracy better than 1 per cent.

Table 1

Material	E_m (erg/gm. min.)	J_m (e.s.u./gm. min.)	$W\rho_m$ (erg/e.s.u.)	(ρ_m)Al / (ρ_m)C	W (eV./ion pair)
C	$2{\cdot}68 \times 10^3$	$2{\cdot}41 \times 10^4$	$0{\cdot}111_2 \pm 0{\cdot}0015$	1·000	$33{\cdot}3 \pm 0{\cdot}5$
Al	$2{\cdot}70 \times 10^3$	$2{\cdot}75 \times 10^4$	$0{\cdot}098 \pm 0{\cdot}001$	0·881	$33{\cdot}1 \pm 0{\cdot}5$

Experiments have been carried out with absorbing cylinders of carbon and aluminium exposed to the beam from our 1,000-curie cobalt-60 unit. The dosage-rate at the position of the cylinders is about 30 r. per minute. After the energy absorption measurements, the cylinders are replaced by air-filled ionization chambers of the same material and same dimensions. The results of a number of experiments are shown in Table 1.

The second column of Table 1 gives the values of the energy absorbed per gm. per min. and is the average of three determinations for each material. The third column shows the corresponding ionization per gm. of air per min. In the fourth column we find the ratio $E_m/J_m = W\rho_m$. Since air was used as the gas in both chambers, the ratio $(\rho_m)\text{Al}/(\rho_m)\text{C}$ can be obtained. This mass stopping-power ratio (0·881) can be compared with the values calculated from the theoretical data of Whyte[1] (0·886) and Spencer[2] (0·866). If we accept Whyte's values for ρ_m, we obtain the values of W for air shown in the last column. The values are about 2 per cent higher than the usually accepted value of 32·5 eV./ion-pair and lower than the value of 35·0 eV./ion pair obtained by Valentine[3]. Further measurements are in progress using other materials (for example, water) and other gases.

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Mineralogy and Crystal Structure of Chamosite

The occurrence of the hydrous ferrous silicate, chamosite, in sedimentary ironstones was described by Hallimond[1]. Later, with Harvey and Bannister[2], he concluded that chamosite differed from the iron-bearing chlorites. Brindley[3,4] examined chamosites from laterites and other sources, and concluded that they were of kaolin-type. Many of the variations in X-ray diagrams were accounted for by the existence of two kaolin-type structures, one ortho-hexagonal and one monoclinic, with simply related cell dimensions. In common with some other clay minerals, chamosite had random displacements of layers parallel to the b-axis of integral multiples of $b/3$, giving rise to sharp (hkl) reflexions only for $k = 3n$. Brindley concluded from the presence of (hkl) reflexions for $h \neq 3n$ that there were no random a-axis

displacements of layers within a single structure, similar to the 'mistakes' in the cobalt structure of Wilson[5] and Edwards, Lipson and Wilson[6]. The pure ortho-hexagonal form was found in an iron ore from the main oolitic beds at Corby, Northamptonshire, by Brindley and Youell[7].

Many chamosites from British sedimentary ironstones have since been examined. All have proved to be of kaolin-type structure. It was clear that, while the mixture of ortho-hexagonal and monoclinic forms accounted for X-ray data from the lateritic chamosites which formed the majority of Brindley's material, there were many variations in the ironstone chamosites which still required explanation. The monoclinic kaolin structure has not been detected in any of these ironstones.

The variation was almost entirely observable in the (20*l*) reflexions. With the exception of the (200) reflexion, which usually remained sharp, these reflexions varied from sharp lines of intensities in accord with the calculated values to weak, diffuse bands. The basal reflexions and some others remained sharp and exhibited no fading comparable with the (20*l*) series. It seems clear that the progressive degeneration of these reflexions corresponds to 'mistakes', in Wilson's sense, of random $a/3$ displacements of layers parallel to the a-axis. In extreme cases of disorder, all the (20*l*) reflexions were absent, and the powder diffraction pattern showed only those lines common to the ortho-hexagonal and monoclinic structures. This disordered chamosite may be regarded as intermediate between the two Brindley structures, the ortho-hexagonal type having no $a/3$ displacements and the monoclinic type having them between all layers.

The degree of disorder can be correlated with the source of the chamosite and its chemical composition. In the main beds of the Northamptonshire Sand Ironstone, the chamosite, here heavily contaminated with siderite, is very highly ordered. Some material gives perfect (20*l*) reflexions, but mostly some fading and broadening occur, typically corresponding to a probability of a fault between layers of 0·05. The main seam of the Cleveland ironstone and the Marlstone ironstone from Banbury contain chamosites in which the (20*l*) series is present although generally not as perfectly as in the Northamptonshire main bed chamosite. The chamosite–kaolinite beds of the Northampton Sand Ironstone contain a chamosite which exhibits a high degree of disorder. The Frodingham ores contain at least two types, a completely disordered structure from a chamosite mudstone, and a moderately ordered structure in siderite-rich material. The ordered chamosites are rich in iron. Disordered chamosites appear generally to contain less iron and more aluminium. The alteration of the diffraction pattern during oxidation to a ferric chamosite also corresponds to the introduction of a-disorder, or to the increase in a-disorder if already present. Both the disorder due to oxidation and that due to variation of source may have a common origin in the reduction of the mean octahedral ionic radius. Ferric chamosite formation involves a change from Fe++ 0·83 A. to Fe+++ 0·67 A., while passage from iron-rich to iron-poor types is accompanied by replacement of Fe++ 0·83 A. by Al+++ 0·57 A. It is significant that disordered chamosite is almost invariably accompanied by kaolinite, and ordered chamosite by siderite.

The continuous series from a-ordered chamosite to a-disordered chamosite may be compared with the corresponding aluminous minerals, a-ordered fireclay and a-disordered metahalloysite.

Thanks are due to Prof. G. W. Brindley for his interest in the work, and to Prof. J. H. Taylor, Dr. W. Davies and Dr. E. Cohen for specimens. A full account of this work will be published later.

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Structure in Vitreous Silicates as shown by Low-angle Scattering of X-Rays

Vitreous substances have been characterized by wide-angle X-ray methods as random, three-dimensional networks possessing no long-range order. Some recent experiments at the lower limits of resolution of the electron microscope[1] have cast doubt on the correctness of this description and suggest that there are regions of different amounts of order in many vitreous silicates.

Since vitreous silicates are somewhat analogous structurally to amorphous organic polymers, it was believed that studies of inhomogeneities in both systems might be related. Accordingly, the low-angle X-ray technique which we use for polymeric systems was applied in a brief survey to some silicate preparations. This technique is capable of detecting inhomogeneities and long-range order below the size limitations of the electron microscope[2].

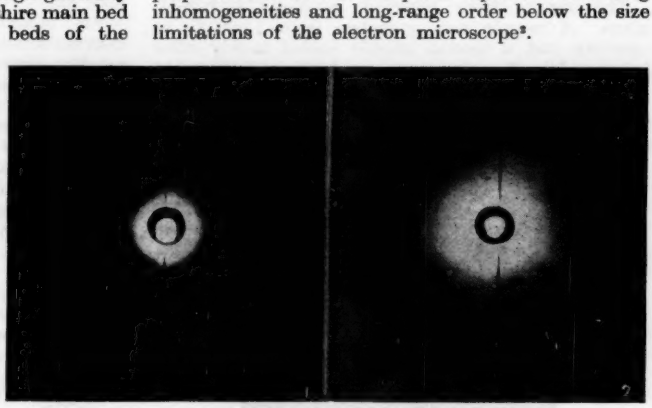

Fig. 1. Low-angle scattering from powder of $Na_2O.MgO.3SiO_2$ quenched into mercury from melt at 1,080° C. Bragg spacing of diffraction ring = 30 A. Sample-film distance = 17 cm.; Kodak 'No-Screen' film, 64-hr. exposure; 0·010 in. sample thickness; copper $K\alpha$ (nickel filtered) radiation

Fig. 2. Low-angle scattering from powder of $Na_2O.MgO.3SiO_2$ slowly cooled from melt at 1,080° C. Same exposure conditions as Fig. 1

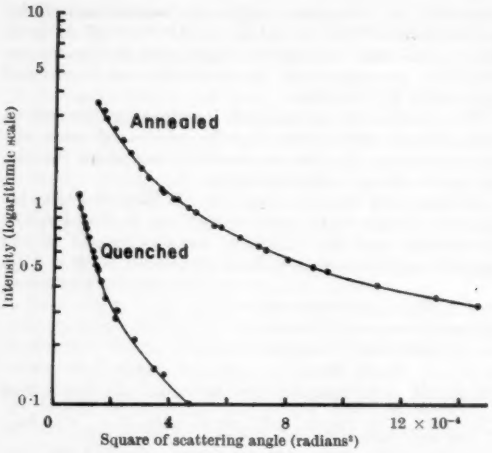

Fig. 3. Diffuse scattering from $Na_2O.MgO.SiO_2$ powders

X-ray patterns at low angles were obtained using filtered radiation for several powdered-glass compositions subjected to a variety of thermal treatments. It was found that these patterns varied in their amount of diffuse scattering and in the presence of a discrete diffraction ring corresponding to a 30-A. spacing. To our knowledge, neither of these effects has been described for simple glasses. We feel they necessitate a revision of the random network theory of these glasses.

A molten drop of silica was captured in mercury to achieve the maximum cooling-rate; another drop was placed in a platinum crucible in a furnace set at 1,080° C. and allowed to cool slowly to room temperature, annealing it. These two samples, after grinding, produced different low-angle X-ray patterns. The chilled sample showed more intense central diffuse scattering than the slowly cooled sample. On the other hand, only the slowly cooled silica glass showed a discrete diffraction ring; the diameter of this ring corresponded to a 30-A. Bragg spacing.

The results were reversed in $Na_2O.MgO.3SiO_2$ glass. A sample was quenched from 1,080° C. in mercury and a second sample cooled slowly after being stabilized at the same temperature. Diffraction patterns of these samples are shown in Figs. 1 and 2. The diffuse scattering extended farther in the annealed than in the chilled glass, and the diffraction ring was present in the chilled, but not in the slowly cooled glass.

The curves in Fig. 3 were obtained from the densitometer traces of the diffuse scattering on the low-angle films of these $Na_2O.MgO.3SiO_2$ powders which had received the different heat treatments. A plot of logarithm of the intensity versus square of the scattering angle in radians can be used to determine the size of the scattering inhomogeneities[2]. Assuming spherical shapes, the size distributions were obtained by the method of Jellinek, Solomon and Fankuchen[3]. The observed curves were resolved into limiting straight lines which corresponded to the following sizes and fractional proportions:

Table 1

Cooling-rate	Size and proportion of inhomogeneities
Slow	24 A. diameter, 77 per cent of the observed scattering
	78 A. " 23 " " " " " "
Fast	68 A. " 55 " " " " " "
	120 A. " 45 " " " " " "

Since we could not record the entire amount of the diffuse scattering to zero scattering angle, these results give a relative proportion of only the smaller inhomogeneities causing the scattering.

It is known that slow cooling compacts glass[4]. The higher proportion of larger inhomogeneities in the quenched $Na_2O.MgO.3SiO_2$ glass suggests that the disorder present at the high temperature was frozen in by the sudden cooling, whereas during slow cooling these regions of low electron density became smaller. Our observation of a reversal of the effects of different cooling-rates in silica glass is supported by the fact that pure SiO_2 glass has opposite properties[4] and insignificant thermal contraction[5].

It is possible that the inhomogeneities causing this diffuse scattering are the same as the 'cracks' or 'flaws' proposed by Griffith[6]. He postulated the elongation of these flaws to explain the unexpectedly high strengths of highly drawn glass fibres. The low-angle pattern shown in Fig. 4 of commercial Owens-Corning 'Fiberglas' confirms the presence of inhomogeneities which are elongated in the direction of the fibre axis.

An unambiguous interpretation of the 30-A. discrete scattering cannot be made with our limited results. However, it is fairly certain to us that these diffraction maxima are evidence for a 'two-phase' or 'micellar' nature of glass, and call for a revision of the random network theory of glass.

It appears that the low-angle X-ray technique is capable of elucidating structure in an amorphous material. Since this is the extent of our interest in silicate systems, we hope the questions raised by our brief experiments will be answered by others.

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Fig. 4. Diffuse scattering from Owens-Corning 'Fiberglas' showing elongated inhomogeneities. Sample-film distance = 17 cm.; Kodak 'No-Screen' film; 80-hr. exposure; 0·010 in. sample thickness; copper $K\alpha$ radiation, nickel filtered. Fibre axis vertical

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Lowered 'Capillary Resistance' after Iontophoresis of Lysergic Acid Diethylamide

THERE is some evidence that 5-hydroxytryptamine may be concerned in hæmostasis (reviewed by Page[1]); but it is difficult to test directly the hæmostatic effect of the drug in normal persons, because, if it has such a role, it is presumably already available in optimal concentration. An attempt was therefore made to weaken the normal hæmostatic system in man by treatment with lysergic acid diethylamide, which Gaddum, Hameed, Hathway and Stephens[2] have found to be a potent inhibitor of 5-hydroxytryptamine on the isolated rat uterus. Because of its effect on the personality, the drug could not be administered systemically. The effect of the drug was therefore investigated by measuring the 'capillary resistance' in small areas of skin which had been infiltrated by iontophoresis.

Solutions of lysergic acid diethylamide were prepared in 0·05 *M* phosphate buffer, *p*H 5·8–6·5 (depending on the solubility of the sample) at concentrations of 10^{-3}, 10^{-3}, 10^{-4} and 10^{-5} (calculated as base), and 0·4 ml. of a given solution was taken up in a thick blotting paper pad 2 sq. in. in area. This was placed on the skin of the anterior aspect of the arm and was made the anode of an iontophoresis circuit, following the method of Barcroft, Bonnar, Edholm and Effron[3] with adrenaline. A current of 2 m.amp. was passed for 5 min. The pad was removed and hæmostasis was tested by measuring the resistance of small vessels to reduced pressure[4]. After noting any existing petechiæ, the total number of petechiæ in the treated arm was successively recorded after reducing the pressure to 100, 150, 200, 250 and 300 mm. mercury below atmospheric. Each pressure was maintained for 30 sec. and the petechial counts were made after returning the test area to atmospheric pressure after each reduction. The symmetrically placed area of skin on the opposite arm was similarly tested after an identical treatment with buffer alone.

No personality changes were noted after these treatments, which suggests that only a small fraction of the drug contained in the pads entered the skin.

Thirty-one series of petechial counts were thus obtained from both arms (the right arm was treated with the drug in twelve tests and the left arm in nineteen tests) in four subjects (three male and one female). The effect of treatment was investigated as follows. For each arm, the petechial count was plotted against the negative pressure, and the count corresponding to − 275 mm. mercury was estimated by linear interpolation. The pressure required to give, on the opposite arm, the lower of these counts was then estimated in the same way. The difference between these pressures was taken as the response; a positive sign was attached if the higher count at − 275 mm. mercury occurred with lysergic acid diethylamide, or a negative sign if with buffer alone.

The mean responses differed significantly from zero only at the two higher doses, being (with standard error) 56·5 ± 26·3 (ten responses; $P = 0·04$) at a dose of 1/1,000, and 100·5 ± 26·3 (ten responses; $P = 0·001$) at 1/100. The slope of the regression of response on logarithm of the dose of lysergic acid diethylamide was also significant ($P = 0·01$) over all the responses. There was no evidence of a systematic difference between the responses from the two arms, from the different sites, from different subjects or from different days of testing; although the number of petechiæ appearing in the untreated skin at a given site exposed to a given fall in pressure clearly varied from subject to subject, and was higher at proximal than at distal sites.

This method of calculating the response was particularly influenced by the high counts obtained at the extreme negative pressures. Two alternative methods of calculating a response, which gave less weight to the extreme pressures, yielded similar results with regressions significant at $P = 0·06$ and 0·08.

It may thus be inferred that, after this treatment with lysergic acid diethylamide at 1/100, and perhaps at 1/1,000, a larger number of petechiæ were produced at a given site by a given fall in pressure than would otherwise have been expected. Nevertheless, in a small series of tests in one subject, no increase in bleeding time was obtained after the iontophoresis of lysergic acid diethylamide into the nail beds of the fingers: the bleeding time was measured in test and control areas under microscopic observation[5].

The present experiments therefore suggest that 5-hydroxytryptamine may at least be concerned in preserving the integrity of undivided small vessels: that is, in preventing the occurrence of purpura.

We are grateful to Dr. I. D. E. Storey for investigating the electrophoretic mobility of lysergic acid diethylamide; to Prof. J. H. Gaddum for advice and encouragement; and to Sandoz Products, Ltd., for generous supplies of lysergic acid diethylamide.

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Turbidimetric Measurement on Synchronized *Salmonella typhimurium* Cultures

SYNCHRONIZATION of cellular and nuclear division in *Salmonella typhimurium* populations at densities of 1–4 × 10^7 cell/ml. has been reported previously[1,2]. Two systems for obtaining such synchronization were described, both systems employing temperature shifts between 25° and 37°. In the first system the temperature of a culture which had been growing for ten generations at 25° was raised to 37°. In the period between 5 and 10 min. following the rise in temperature, 80–90 per cent of the population underwent nuclear division as observed cytologically[2], and as inferred from the interaction of the cells with a temperate bacteriophage. On the other hand, cellular division, as measured by colony counts, was delayed for 20–25 min., at which time it took place at an increased rate, finally re-establishing the exponential growth of the culture at the normal 37° rate (see Fig. 1).

In the second system, a culture just entering the exponential phase of growth at 37° was subjected to

alternating cycles of 28 min. at 25° and 8 min. at 37°. In this case synchronized cellular division was usually obtained in the third and fourth cycles, cellular division occurring during the 37° period (Fig. 2). On the basis of the interaction of the cells with a temperate phage, it was concluded that nuclear division had also been synchronized.

When these studies were reported it was believed that the two systems bore a simple relationship to one another in that the primary effect of raising the temperature was to induce nuclear division. Recent turbidimetric studies in this laboratory, while not contradicting this hypothesis, have revealed a basic difference between these two systems.

Cultures of *Salmonella typhimurium* were subjected to the two treatments described above and the increase in cell number and mass were followed by means of colony counts and turbidimetry[4] respectively. 6-ml. samples to be studied turbidimetrically were removed and mixed with 0·05 ml. of 40 per cent formalin, and read within 15 min.; identical results were obtained using the Klett–Summerson colorimeter, fitted with a No. 69 filter, and a Hilger spectrophotometer, at $\lambda = 650$ mμ.

The results obtained with the two systems are presented in Figs. 1 and 2. As may be seen in Fig. 1, following the single temperature shift from 25° to 37°, the turbidity of the culture continues to rise exponentially at the 37° rate, whereas the counts of viable cells increase at a lower rate. This results in an increase in turbidity, or mass, per cell. The single temperature shock which induces nuclear division 5–10 min. later without inducing a simultaneous cellular division is thus not sufficient to affect the synthesis of new cell material. On the other hand, repeated cycling between 25° and 37° results in a synchronization of both the turbidity increment and cell division (Fig. 2). The repeated induction of both nuclear and cellular division obtained in such an experiment leads the growth of the population to exhibit a synchronous pattern in terms of mass as well as numbers.

In the latter system the growth pattern of the population may be considered to reflect the growth characteristics of the individual cell. Results obtained with Protozoa[5], together with the data in Fig. 2, would suggest that this growth characteristic is as follows: in the normal division cycle of a single *Salmonella typhimurium* cell, cellular and nuclear division are followed by an arithmetical increase in mass, ceasing shortly before the next cell division. A full account of these experiments will be published elsewhere.

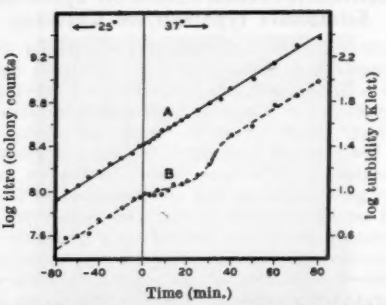

Fig. 1. Single temperature shift experiment. Aerated culture of *Salmonella typhimurium* growing exponentially for more than ten generations at 25° in broth (ref. 2) (diluted fivefold). At $t = 0$ temperature was raised within 20 sec. to 37°. Culture was diluted periodically to maintain a titre of 2–4 × 10^7. For convenience of representation the time-scale has been doubled after $t = 0$. *A*, ●—●, turbidimetric readings in Klett colorimeter; *B*, ●- - -●, viable titre measured as colony count. Turbidity and colony counts are corrected for culture dilutions. The normal growth-rates at 25° and 37° in broth 5 are represented by the continuous line of curve *A*

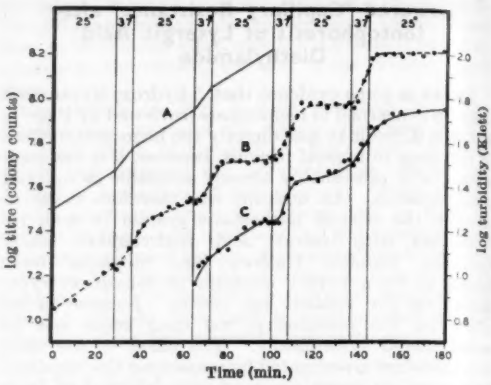

Fig. 2. Repeated temperature cycling experiment. An overnight 37° culture of *Salmonella typhimurium* was diluted 1/100 in broth 5, grown with aeration from $t = -90$ min. to $t = 0$ min. at 37°, and then subjected to alternate cycles of 25° and 37°. The hot or cold broth, added to raise or lower the temperature of the culture, maintained the titre between 2 and 4 × 10^7 cells/ml. *A*, ——, compound exponential growth curve constructed from the normal generation times of *Salmonella typhimurium* in broth 5 at 25° and 37°; *B*, ●- - -●, turbidimetric reading in Klett colorimeter; *C*, ●—●, viable titre measured as colony count. Turbidity and colony counts have been corrected for culture dilutions

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Approximate Joint Probability Distribution for Wave Amplitude and Frequency in Random Noise

In the study of the observed properties of random noise, for example, ocean wave records, it has been pointed out by Barber[1] that, for a narrow spectrum, the probability distribution of amplitude approximates to the distribution of the wave envelope. Since the latter distribution is simple to use and gives a good fit for the higher waves, the approximation is of practical value, and has been discussed in the literature by Longuet-Higgins[2] and Watters[3].

An attempt has been made to derive an analogous formula for the joint distribution of amplitude and frequency of the main waves, neglecting small waves which occur away from the mean.

Following a suggestion made by Mr. N. F. Barber, it is possible to define the amplitude R of the wave envelope as the modulus of the vector

$$v(t) = R(t) \exp i\theta(t) \quad (1)$$

in such a way that the original noise signal is represented by the real part of $v(t)$. This definition can be shown to lead to results in accordance with those derived from the usual definition (cf. Rice[4]).

For a narrow spectrum it is reasonable to assume that the angular velocity $\theta'(t)$ will be closely related to the 'instantaneous' frequency (cf. Rice[5]) as recorded by an observer. Consequently the joint probability distribution of $R(t)$ and of $\theta'(t)$ is of interest. This joint distribution, in standard measure, is found to be:

$$2\pi^{-1/2}\, d\alpha\, dz\, z^3 \exp\left[-z^2(1+\alpha^2)\right] \quad (2)$$

where

$$z = R/E^{1/2} \quad (3)$$

is the 'normalized' envelope amplitude, and

$$\alpha = E \begin{vmatrix} E & -E_1 \\ E_1 & -E_2 \end{vmatrix}^{-1/2} (\theta' - |E_1|/E) \quad (4)$$

is the 'normalized' deviation of θ' from its mean value. Here

$$E = \text{av.}\,(|v|^2),\ E_1 = \text{av.}\,(v'^*v),\ -E_2 = \text{av.}\,(|v'|^2) \quad (5)$$

are coefficients in the Hermitian co-variance matrix of $v(t)$ and its first time derivative.

Evidently the distribution of $\theta'(t)$ is symmetrical about the mean

$$\text{av.}\ \theta' = |E_1|/E \quad (6)$$

and there is less scatter in $\theta'(t)$ for large values of $R(t)$ than for small. A practical inference is that it would be better, when making visual observations of ocean waves, to estimate mean frequency from the groups of high waves that occur from time to time than by measuring all the waves. A further inference is that the mean frequency of the high waves will tend to the value (6) rather than to the expected half-frequency of zeros $(-E_2/E)^{1/2}$, (Rice[6]), which results when all waves are considered.

A more detailed account of this work will be published in the *New Zealand Journal of Science and Technology*.

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Use of a Computing Machine as a Mechanical Dictionary

In considering the application of an automatic calculator to problems of mechanical translation, the first need which arises is the storage of a dictionary[1]. It has been shown[2] that the naïve scheme in which the translation is contained in that storage location the address of which is given by the number that results from numerical encoding of the foreign-language word is not practical, and the procedure which has been adopted up to the present has been to store the dictionary in a sequence of locations. The order of storage is such that the code number of the foreign language portions of the words are in ascending order of magnitude. To select the entry corresponding to a given foreign-language word, the code number of that word is subtracted successively from the dictionary entries starting from the first. The result of such a subtraction will always be negative until the required position is reached, when the searching process is discontinued and the next phase of the translation operation is initiated.

It is evident that, for a dictionary which contains N words, an average of $N/2$ subtractions will be required to locate a word chosen at random. Since N may be between 10^4 and 10^5, and the subtraction and access times on many machines amount to about 10^{-3} sec., the time to locate a given word will lie between 5 and 50 sec.

To reduce this time, a possible method is to store words whjch start with the same letter in storage locations the code numbers of which are related to those of the initial letters. This reduces the time of search by a factor of about 23, but has the disadvantage that some blocks of locations will be only partially filled.

An alternative approach to the problem of dictionary search is as follows. For convenience it will be assumed that entries are stored in locations 1 to N, and the unknown word is first subtracted from the dictionary entry in location $N/2$. If the result is positive, the required entry is either that contained in position $N/2$, or it is contained in one of the locations $N/2$ to N. If the result of the subtraction is negative, the required entry lies in locations 1 to $(N/2 - 1)$. In the former case the comparison is repeated on the entry contained in location $(N/2 + N/4)$, and in the latter case on the entry in $(N/2 - N/4)$. This process is repeated until the unknown position is isolated.

The importance of the method lies in the very small number of comparisons which are needed to isolate an entry. Thus, for a dictionary of 10^4 words, less than 14 comparisons will isolate any given word, and for 10^6 words 20 comparisons should suffice. The time of search required for the example quoted earlier would thus be reduced to less than 20 m.sec.

In practical application it is not usual for N to be of the form 2^m, so that instead of the numbers $N/2$, $N/4$, . . ., etc., it is sufficient to take the nearest integer to these values.

An amusing lecture demonstration is based upon this process. A member of the audience selects a word at random from the "Concise Oxford Dictionary"; by asking a maximum of 14 questions the lecturer is then able to find the word selected. A simple form of the question is "Does the word come before . . . ?" in the dictionary. Partition need only be approximate and a rough division of the dictionary into $\frac{1}{2}$, $\frac{1}{4}$, etc., by eye is sufficient.

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[1] Booth, A. D., and Booth, K. H. V., "Automatic Digital Calculators", 15 (Butterworths, London, 1953).
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FORTHCOMING EVENTS

Monday, September 19—Friday, September 23

Fédération Internationale Pharmaceutique (at Senate House, University of London, Malet Street, London, W.C.1), at 9.30 a.m. daily—16th General Assembly.

Tuesday, September 20—Friday, September 23

Library Association (at Southport)—Annual Conference.

Wednesday, September 21—Thursday, September 22

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 10 a.m. daily—Conference on "The Correlation between Calculated and Observed Stresses and Displacements in Structures".

Wednesday, September 21—Friday, September 23

Society for Water Treatment and Examination (at Newcastle-upon-Tyne)—Autumn Meeting.

Thursday, September 22—Saturday, September 24

British Society of Rheology (at the Washington Singer Laboratories of the University College, Prince of Wales Road, Exeter)—Symposium on "Surface Rheology".

Friday, September 23—Saturday, September 24

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1)—Symposium on "Some Recent Developments in Magnetic Materials".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Metallurgist (with an honours degree in metallurgy or A.I.M., and several years practical experience in industry and preferably some knowledge of the metallurgical problems associated with electrical power generation) in the Chief Engineer's Department, Bankside House, London, S.E.1—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting AE/660 (September 23).

Lecturer (with high qualifications in mathematics and good teaching experience) in Mathematics—The Principal, Derby Technical College, Normanton Road, Derby (September 24).

Senior Lecturer (with a good honours degree, and experience in the application of statistics, preferably in industry) in Statistical Methods, a Senior Lecturer (preferably with some industrial experience) in Mathematics, and a Lecturer (with good academic qualifications) in Mathematics—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 24).

Economist (with first- or second-class honours degree in economics, statistics or kindred subject, with ability to write clearly and concisely and preferably with knowledge of British agriculture and trade)—The General Secretary, National Farmers' Union, 45 Bedford Square, London, W.C.1 (September 26).

Head of the Physics Department—The Principal, Derby Technical College, Normanton Road, Derby (September 26).

Assistant Experimental Officer or Experimental Officer (graduate) in the Bee Department, for work on bee behaviour—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (September 30).

Assistant Lecturer (with an interest in, and ability to teach, theoretical physics) in Physics—The Registrar, University College of North Staffordshire, Keele, Staffs (September 30).

Lecturers (2) (with a special knowledge of one of the following fields: electrical machinery, vibration analysis and engineering acoustics, communications (other than radio)) in Electrical Engineering—The Secretary of University Court, The University, Glasgow (September 30).

Mathematicians, Scientific Officer grade (with a first- or second-class honours degree in mathematics or equivalent qualifications), at the Ministry of Supply Headquarters in London, for (*a*) to investigate data reduction associated with ballistic instrumentation, with a view to improving methods of presentation of results and to introducing methods of analysis applicable to automatic computing machines; and (*b*) for theoretical and experimental work in external ballistics, analysis of trials results and application to assessment of performance—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.331/5A (September 30).

Professor of Mechanical Engineering at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Ceylon, September 30).

Scientific Officer (with an honours degree in biochemistry or similar qualification) in the Biochemistry Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (October 3).

Principals (with a degree in engineering or equivalent, and with industrial and teaching experience) in the Gold Coast Civil Service, to take charge of Technical Institutes—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.114/13/01 (October 4).

Senior Lecturer or Lecturer in Physical Chemistry or Inorganic Chemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 7).

Lecturer in Zoology at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 31).

Assistant Biochemist, Basic grade (with a B.Sc. degree with honours in chemistry or biochemistry or an equivalent qualification) in the Department of Pathology—The Group Secretary, Wolverhampton Hospital Group, The Royal Hospital, Wolverhampton.

Fison Research Fellow (with a good honours degree in science or agricultural science, and postgraduate experience), for work on (*a*) the role of the soil fauna in soil fertility, or (*b*) the mineral nutrition of the leguminous pasture plants—The Registrar, The University, Nottingham.

Hospital Physicist (with an honours degree in physics, and preferably with experience in hospital physics) in the Radiotherapy Department—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford.

Lecturer (graduate of a British university, and with industrial experience) in Power Engineering—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

Lecturer (with a good honours degree and research experience) in Botany, at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2.

Principal Scientific/Senior Scientific Officer (with a first- or second-class honours degree in chemistry or equivalent, a good general knowledge of modern research developments in lubricants and fuels, and preferably with some experience of the petroleum industry) at the Ministry of Supply Headquarters in London, for the initiation and progressing of basic research and development work, in industry and a Ministry Laboratory, on lubricants and petroleum fuels—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.674/5A.

Research Assistants (honours graduates in chemistry, preferably with a specialized knowledge of inorganic or physical chemistry) in the Department of Applied Science—The Clerk to the Governors, Wolverhampton and Staffordshire Technical College, Wolverhampton.

Senior Chemist (with a good honours degree in organic chemistry or biochemistry, and preferably with some research experience and/or industrial experience), for work mainly concerned with various aspects of cereal chemistry, flour lipids, and the technology of baked products—The Director of Research, British Baking Industries Research Association, Chorleywood, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

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Royal Institute of Chemistry. Register of Fellows and Associates, 1954. Pp. xx+534. (London: Royal Institute of Chemistry, 1955.) [67

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Other Countries

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